Fourth Five-Year Review Report for

Advanced Micro Devices 901/902 & TRW Microwave

Superfund Sites

Includes the "Companies' Offsite Operable Unit"

Santa Clara County, California

PREPARED BY

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9/30/14
Date

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Executive Summary

This document presents the fourth Five-Year Review (FYR) for the Advanced Micro Devices 901/902 Thompson Place (AMD 901/902 or AMD) and TRW Microwave (TRW) Superfund sites located in Sunnyvale, California. This document also includes the first FYR of the Companies' Offsite Operable Unit (Offsite OU or OOU), the area of the neighborhood outside the AMD and TRW facilities' boundaries which has been impacted by groundwater contamination from these sites. This adjacent OOU has not previously been included in the FYR process. The purpose of this FYR is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this FYR was the signing of the previous separate FYRs for AMD and TRW sites on September 30, 2009.

The United States Environmental Protection Agency (EPA) issued a joint Record of Decision (ROD) in 1991 that addressed the following four Operable Units (OUs), informally known by the collective term "Triple Site":

- AMD 901/902 Thompson Place site OU;
- Philips Semiconductors (formerly Signetics) site OU;
- TRW Microwave site OU; and
- Companies' Offsite OU.

The Philips Semiconductors (Philips) site was proposed for listing on the National Priorities List (NPL), but was never ultimately listed. The Philips site was previously regulated under the state-authorized Resource Conservation and Recovery Act (RCRA) program. On August 7, 2014 EPA Region 9 and the State of California, San Francisco Bay Regional Water Quality Control Board (Regional Board), agreed to transfer lead agency oversight responsibilities the Triple Site from the Regional Board to EPA Region 9. EPA is thus now the lead agency overseeing environmental investigation and remediation work at the Triple Site and associated Offsite OU.

This FYR addresses the AMD, TRW, and Offsite OUs. The Philips OU is not addressed in this document. In general, one or more chemicals of concern (COC) remain at concentrations above cleanup standards in the AMD, TRW, and Offsite OUs.

AMD 901/902

The former 901 and 902 Thompson Place buildings were historically used for manufacturing printed circuit boards and semiconductors between 1969 and 1992. Operations ceased in 1992 and the buildings were later demolished and replaced in 2007 with a self-storage warehouse. During AMD operations, trichloroethylene (TCE) and other industrial solvents were used for cleaning and degreasing. Acid neutralization systems (ANS), including in-ground sumps, were used at both AMD buildings between 1969 and 1984. Site investigations were initiated in 1982 due to leakage from an ANS near building 901; subsequently, the ANS sump in building 902 was also found to be leaking.

Soil and groundwater was contaminated with chlorinated volatile organic compounds (VOCs), primarily TCE and its biodegradation products, cis-1,2-dichloroethylene (cDCE) and vinyl chloride (VC).

EPA selected the following remedy for the AMD 901/902 OU in the 1991 ROD:

- Soil excavation;
- Groundwater extraction and treatment;
- Groundwater monitoring; and
- Placement of a restrictive covenant prohibiting installation of onsite wells until the completion of groundwater remediation.

Soil excavation was completed in 1992, followed by a No Further Action letter issued by the Regional Board in 2008. The groundwater remedy as described in the ROD (a groundwater extraction and treatment system [GWETS]) is no longer operating. The GWETS began operation in 1983 but was discontinued due to declining effectiveness. Portions of the GWETS are now used in conjunction with an in-situ bioremediation (ISB) program to inject and circulate carbohydrate amendment. When in operation, extracted groundwater is treated with granular activated carbon (GAC) and re-injected at the site. A revised Focused Feasibility Study (FFS) was submitted in October 2013 and is awaiting approval from EPA. EPA will use the evaluation of alternatives in the FFS to select a final remedy for the site.

Five chemicals of concern (COCs) remain at concentrations above groundwater cleanup standards at the site. Contamination is confined to the shallow groundwater-bearing zones (A, B1, and B2 zones). Remedial efforts have greatly reduced TCE concentrations in the original source areas. Levels of TCE degradation products (cDCE and VC) have seen recent increases in the ISB treatment areas, indicating that degradation is occurring but that it is incomplete. Contamination from off-site up-gradient sources continues to be an issue.

There have been no changes to groundwater cleanup levels since the ROD. Toxicity revisions have occurred for several chemicals, but the revisions do not affect protectiveness. Land use has not changed since the last FYR. Exposure pathways from soil and groundwater are being controlled through institutional controls. A 2005 covenant prohibits residential development for human habitation; construction or use of medical facilities, day-care centers, or schools; or use of groundwater or excavation of soils without prior approval of the Regional Board. The current status of the existing covenant was not investigated in this FYR.

Vapor intrusion was most recently evaluated in 2014 at the self-storage warehouse occupying the former site of the 901 and 902 Thompson Place buildings; results indicate that the potential indoor air exposures due to site groundwater contamination are not a concern. However, the need for vapor intrusion evaluations was not assessed for the remaining seven buildings currently occupying the site, but located upgradient of the former source area.

The remedy at the AMD 901/902 OU currently protects human health and the environment by controlling exposure pathways that could result in unacceptable risks. However, in order for the remedy to be protective in the long-term, the ROD will need to be amended to reflect a revised final groundwater remedy for the site since the remedy selected in the ROD is no longer operating.

TRW

Between 1968 and 1993, activities at the TRW OU included assembly and testing of microwave and semiconductor components. Operations involved the use of TCE. Other industrial solvents and hazardous wastes were generated as a by-product of operations. Waste solvents, primarily TCE, were stored in an underground storage tank (UST) from 1970 to 1982. The UST, which was removed in 1983, was the source of soil and groundwater contamination at the site.

In the 1991 ROD, EPA selected the following remedy for the TRW OU:

- Groundwater extraction;
- Treatment of extracted groundwater by air stripping;
- Discharge of treated water under a National Pollutant Discharge Elimination System (NPDES) permit; and
- Institutional controls, including restrictive and environmental covenants, which include prohibiting residential land use, no extraction of groundwater, and continued monitoring of groundwater.

Five COCs remain at concentrations above groundwater cleanup standards at the site. Contamination is contained in the shallow groundwater bearing zones (A, B1, and B2 zones). VOC concentrations are declining over time but remain significantly above cleanup levels in the source area, indicating that the former source area may still be contributing to groundwater contamination. Concentrations of TCE and cDCE increased in the down-gradient B1 and B2 zones, suggesting that the on-site remedy may not be effectively containing offsite migration. Migration of contamination from off-site up-gradient sources continues to be a concern.

Groundwater extraction and treatment occurred at the site between 1986 and 2001. Between 1993 and 1998, soil vapor extraction and treatment (SVET) was also used to facilitate cleanup of residual contamination in the unsaturated zone in the vicinity of the former UST area. Due to declining effectiveness, the groundwater extraction and treatment portion of the remedy was discontinued in 2001. The responsible party (RP) subsequently proposed enhanced anaerobic biodegradation (EAB) as a revised remedy for groundwater. Pilot testing for EAB began in 2000 and was expanded in 2005. EAB has achieved some success in reducing COC concentrations, although rebound has been observed. A draft FFS was completed in 2011, however finalization has been delayed so as to include recently obtained vapor intrusion data.

Vapor intrusion investigation and mitigation activities are ongoing at the TRW site on-property building to address screening level exceedances indicative of a potential for unacceptable indoor air

exposures. However, the building is currently unfinished and unoccupied, and mitigation work and confirmation sampling will be completed prior to a tenancy.

There have been no changes to groundwater cleanup levels since the ROD was issued. Toxicity revisions have occurred for several chemicals, but the revisions do not affect protectiveness. Land use has not changed since the last FYR. Exposure pathways for soil and groundwater are being controlled through institutional controls. A restrictive covenant that prohibits use of groundwater or excavation of soils was recorded in 1989. However, a new restrictive covenant may need to be completed as the existing covenant was recorded prior to the passage of California Civil Code (CCC) section 1471, which was passed in 1995 and established the framework for environmental covenants in California.

The remedy at the TRW OU currently protects human health and the environment because exposure pathways for soil and groundwater are being controlled. Exposure pathways to contaminated groundwater that could result in unacceptable risks are prevented through an environmental covenant. The risk due to vapor intrusion is controlled as long as the building remains unoccupied and the exposure pathway remains incomplete. However, in order for the remedy to be protective in the long-term, the ROD will need to be amended to reflect a revised final soil and groundwater remedy for the site since the remedy selected in the ROD is no longer operating.

Offsite OU

The OOU extends north from the Philips OU and encompasses an area of about 100 acres (roughly twice the size of the combined Philips, TRW, and AMD OUs). The area includes four schools and over 100 residential properties, including the former Sunnyvale High School buildings, which are currently used as a child development center (a combined daycare and preschool). The three remaining schools include two elementary schools (one private and one public) and one private high school. The Offsite OU includes the largest residential neighborhood of all of the National Priorities List (NPL) sites in the South Bay Area under the oversight of the State of California. Further, it includes a high concentration of sensitive populations, including an infant daycare and pre-school, two elementary schools and one high school, as well as a residential area of over 100 homes.

Contamination in the OOU is due to up-gradient contamination sources, such as the Philips, TRW, and AMD OUs.

In 1991 ROD, EPA selected the following remedy for the OOU to be protective in the long-term of human health and the environment:

- Expanded groundwater extraction;
- Treatment of extracted groundwater by air stripping (at the neighboring AMD 915 DeGuigne Drive Superfund site); and
- Reuse or discharge of the treated groundwater to surface water under an NPDES permit.

Groundwater data indicate that two COCs (TCE and cDCE) remain at levels above cleanup standards in the shallow aquifer zones. The remedy is effectively containing contaminants migrating from up-gradient sources and is preventing further down-gradient migration.

The groundwater extraction network has been expanded since the ROD and currently operates with 29 extraction wells. Until 2010, extracted groundwater from the OOU was processed at the treatment facility located at 915 DeGuigne Drive and discharged under an NPDES permit. Starting in October 2010 and continuing through the present time, extracted groundwater is routed to the treatment facility located at the Philips site. Treated effluent is discharged to the Sunnyvale East Channel in accordance with NPDES Permit No. CAG912003.

There have been no changes to groundwater cleanup levels since the ROD. Toxicity revisions have occurred for several chemicals, but the revisions do not affect protectiveness. Land use is primarily residential. Institutional controls are in place to prevent well installation in Santa Clara County, and a municipal water supply exists for the area (Hetch Hetchy Reservoir in the Sierra Nevada Mountains).

A vapor intrusion assessment was most recently conducted at the 790 East Duane Avenue property in 2013, which is currently occupied by a school. Based on the results of this indoor air sampling event, levels of VOCs at this school due to vapor intrusion are considered protective of human health during the Heating, Ventilation, and Air Conditioning (HVAC) system conditions at the time of sampling. Indoor air sampling was also conducted in 2004 and 2005 at school buildings located at 562 North Britton Avenue. Per the recent EPA Region 9 vapor intrusion recommendations, additional evaluation is needed at these and other neighborhood schools (including with HVAC systems turned off).

The properties at 790 East Duane Avenue and 562 North Britton Avenue represent only a small portion of the OOU that overlies groundwater contaminated with TCE concentrations greater than 5 µg/L. EPA's understanding of contaminant migration from soil gas and/or groundwater into indoor air has evolved over the past few years leading to the conclusion that vapor intrusion may have a greater potential for posing risk to human health than previously assumed. Concentrations of COCs in groundwater indicate the potential for vapor intrusion risk. Additional vapor intrusion assessment is recommended at other schools, residences and commercial buildings in the Offsite OU.

A protectiveness determination of the remedy at the OOU cannot be made at this time until further information is obtained. Vapor intrusion assessments must be conducted to determine if indoor air pathways are complete. If unacceptable levels are encountered in a particular building, mitigation plans will be implemented to ensure that levels of VOCs in indoor air are protective. EPA has begun a vapor intrusion assessment and expects that these activities will take approximately two years to complete, at which time a protectiveness determination can be made.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Advanced Micro Devices 901/902 and TRW Microwave Superfund Sites		
EPA ID: CAD048634059 (AMD) and CAD009159088 (TRW)		
Region: 9	**State:** CA	**City/County:** Sunnyvale, Santa Clara County

SITE STATUS	
NPL Status: Final	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:**
Author name (Federal or State Project Manager): Melanie Morash
Author affiliation: USEPA Region 9
Review period: October 1, 2013 - September 30, 2014
Date of site inspection: October 24, 2013
Type of review: Statutory
Review number: 4
Triggering action date: September 30, 2009
Due date *(five years after triggering action date)*: September 30, 2014

Five-Year Review Summary Form (continued)

The table below is for the purpose of the summary form and associated data entry and does not replace the two tables required in Section VIII and IX by the FYR guidance. Instead, data entry in this section should match information in Section VII and IX of the FYR report.

Issues/Recommendations				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): AMD 901/902	**Issue Category: Remedy Performance**			
	Issue: The remedy selected for the Site is no longer being operated.			
	Recommendation: Select a revised cleanup plan and prepare a revised EPA decision document.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	09/2016
OU(s): TRW	**Issue Category: Remedy Performance**			
	Issue: The remedy selected for the Site is no longer being operated.			
	Recommendation: Select a revised cleanup plan and prepare a revised EPA decision document.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	09/2016
OU(s): TRW	**Issue Category: Monitoring**			
	Issue: Groundwater contamination is inadequately characterized in the source area and down-gradient B3 zone.			
	Recommendation: Add source area and down-gradient B3 zone wells to the suite of annual monitoring wells.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	09/2015
OU(s): TRW	**Issue Category: Remedy Performance**			
	Issue: Increasing COC concentrations in downgradient wells indicates that the remedy is not containing offsite migration.			
	Recommendation: Investigate and implement optimization options for the ISB to increase downgradient capture zone groundwater contamination.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	09/2015
OU(s): Offsite	**Issue Category: Changed Site Conditions**			

	Issue: Groundwater concentrations in the off-site plume indicate a potential for vapor intrusion in an area with 4 schools and over 100 residences. There has been limited indoor air sampling in the area .			
	Recommendation: Conduct additional vapor intrusion assessments at the site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Unknown	Yes	PRP	EPA	09/2015

Protectiveness Statement – AMD 901/902		
Operable Unit: AMD 901/902	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* NA
Protectiveness Statement: The remedy at the AMD 901/902 OU currently protects human health and the environment by controlling exposure pathways that could result in unacceptable risks. However, in order for the remedy to be protective in the long-term, the ROD will need to be amended to reflect a revised final groundwater remedy for the site since the remedy selected in the ROD is no longer operating.		

Protectiveness Statement - TRW		
Operable Unit: TRW Microwave	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* NA
Protectiveness Statement: The remedy at the TRW OU currently protects human health and the environment because exposure pathways for soil and groundwater are being controlled. Exposure pathways to contaminated groundwater that could result in unacceptable risks are prevented through an environmental covenant. The risk due to vapor intrusion is controlled as long as the building remains unoccupied and the exposure pathway remains incomplete. However, in order for the remedy to be protective in the long-term, the ROD will need to be amended to reflect a revised final soil and groundwater remedy for the site since the remedy selected in the ROD is no longer operating.		

Protectiveness Statement – Offsite OU		
Operable Unit: Offsite OU	*Protectiveness Determination:* Protectiveness Deferred	*Addendum Due Date (if applicable):* September 30, 2016
Protectiveness Statement: A protectiveness determination of the remedy at the OOU cannot be made at this time until further information is obtained. Vapor intrusion assessments must be conducted to determine if indoor air pathways are complete. If unacceptable levels are encountered in a particular building, mitigation plans will be implemented to ensure that levels of VOCs in indoor air are protective. EPA has begun a vapor intrusion assessment and expects that these activities will take approximately two years to complete, at which time a protectiveness determination can be made.		

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List of Abbreviations

AMD	Advanced Micro Devices, Inc.
ANS	acid neutralization system
ARAR	applicable or relevant and appropriate
bgs	below ground surface
BPHE	Baseline Public Health Evaluation
CA	California
CCC	California Civil Code
cDCE	cis-1,2-dichloroethylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
1,1-DCA	1,1-dichloroethane
1,2-DCB	1,2-dichlorobenzene
1,1-DCE	1,1-dichloroethene
DTSC	Department of Toxic Substances Control
EAB	enhanced anaerobic bioremediation
EPA	Environmental Protection Agency
ESL	Environmental Screening Level
EVO	emulsified vegetable oil
FFS	Focused Feasibility Study
FS	Feasibility Study
FYR	Five-Year Review
GAC	granular activated carbon
GWET	groundwater extraction and treatment
GWETS	groundwater extraction and treatment system
HRC	hydrogen release compound
HVAC	heating ventilation and air conditioning
IC	institutional control
IRIS	Integrated Risk Information System
ISB	in-situ bioremediation
IUR	inhalation unit risk
MCL	Maximum Contaminant Level
MIP	Membrane Interface Probe
MNA	monitored natural attenuation
NCP	National Contingency Plan
NFA	No Further Action
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OOU	Offsite operable unit
OU	operable unit
PCE	tetrachloroethylene
PID	photoionization detector
PVC	polyvinyl chloride
RA	Remedial Action
RAP	Remedial action Plan
RCRA	Resource Conservation and Recovery Act
RfCi	inhalation reference concentration

RfDo	oral reference dose
RI	Remedial Investigation
ROD	Record of Decision
RP	responsible party
RSL	Regional Screening Level
RWQCB	Regional Water Quality Control Board
SCR	Site Cleanup Requirements
SCVWD	Santa Clara Valley Water District
SFo	oral slope factor
SFPUC	San Francisco Public Utilities Commission
SVET	soil vapor extraction and treatment
1,1,1-TCA	1,1,1-trichloroethane
TCE	Trichloroethylene
tDCE	trans-1,2-dichloroethylene
TRW	TRW Microwave
µg/L	microgram per liter
$\mu g/m^3$	micrograms per cubic meter
USACE	United States Army Corps of Engineers
UST	underground storage tank
VC	vinyl chloride
VI	vapor intrusion
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compound

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Fourth Five-Year Review Report
for
Advanced Micro Devices 901/902 and
TRW Microwave Superfund Sites
Includes the Companies' Offsite Operable Unit

1. Introduction

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of FYRs are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

> "*If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*"

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> "*If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often than every five years after the initiation of the selected remedial action*."

This is the fourth FYR for the Advanced Micro Devices, Inc (AMD) 901/902 and TRW Microwave (TRW) sites. The triggering action for this statutory review is the previous FYRs prepared separately for the AMD and TRW OUs, both dated September 30, 2009. This review and report is for both the AMD and TRW sites, as well as the associated Offsite operable unit (Offsite OU or OOU) – the area of the neighborhood outside the AMD and TRW facilities' boundaries which has been impacted by groundwater contamination from these sites. This adjacent OOU has not previously been included in the FYR process.

The FYR is required because hazardous substances, pollutants, or contaminants currently remain at the sites at levels above those that would allow for unlimited use and unrestricted exposure and cleanup of the site will take five years or more to complete.

EPA Region 9 and the U.S. Army Corps of Engineers (USACE) conducted the FYR and prepared this report regarding the remedy implemented at the AMD and TRW Superfund sites in Sunnyvale, Santa Clara County, California. On August 7, 2014, EPA Region 9 and the State of California, San Francisco Bay Regional Water Quality Control Board (Regional Board) agreed to transfer lead agency oversight responsibilities for the AMD and TRW sites, the neighboring Philips site, and the associated Offsite OU (informally known by the collective term "Triple Site") from the Regional Board to EPA Region 9.

The Regional Board had previously been the lead agency for the Triple Site pursuant to the South Bay Multi-Site Cooperative Agreement and the South Bay Groundwater Contamination Enforcement Agreement, established on May 2, 1985, by the Regional Board, California Department of Health Services and EPA Region 9. In June 1991, the Regional Board issued three orders requiring site cleanup by AMD, TRW, and Philips:

- Order No. 91-102, issued to AMD for the 901/902 Thompson Place property
- Order No. 91-103, issued to TRW for the TRW Microwave property
- Order No. 91-104, issued to Signetics (also known as "Philips Semiconductor")

Subsequently, in September 1991, EPA issued a combined Record of Decision (ROD) that identified four Operable Units (OUs), three of which are addressed in this FYR (Figure 1):

- Signetics, Inc. (also referred to as the "Philips" site)
- AMD 901/902 site (AMD)
- TRW Microwave site (TRW)
- Companies' Offsite OU (Offsite OU)

Figure 1 shows the location of the AMD, Philips, TRW, and Offsite OUs. The AMD 915 Superfund site shown on the figure is addressed under a separate ROD and is not addressed in this FYR. The Philips site was proposed for listing on the National Priorities List (NPL), but was never ultimately listed. Until August 7, 2014, the site was regulated under the state-authorized Resource Conservation and Recovery Act (RCRA) program. The Philips OU is not addressed in this FYR.

The AMD OU includes soil and groundwater contamination. The selected remedy for soil consisted of soil excavation followed by offsite incineration/disposal. The remedy for groundwater originally consisted of extraction and air-stripper treatment of groundwater with reuse of the treated water, but these activities were ultimately discontinued due to declining effectiveness. In-situ bioremediation (ISB) was subsequently initiated and continues to the present time.

The TRW OU contains soil and groundwater contamination. The remedy for soil consisted of soil excavation (with offsite disposal) and soil vapor extraction and treatment (SVET). The original remedy

for groundwater consisted of groundwater extraction and treatment of extracted groundwater with air strippers, with discharge of treated groundwater to the storm drain. In 2000, enhanced anaerobic bioremediation (EAB) was initiated, and in 2001 the groundwater extraction and treatment system (GWETS) was shutdown.

The Offsite OU was generally defined in the ROD as the area inside the 5 microgram per liter (µg/L) isopleth for trichloroethylene (TCE) in groundwater. According to the ROD, this area begins north of the Philips OU and extends to just north of Lakehaven Drive, past Highway 101 (Figure 1). The remedy for groundwater in the Offsite OU consists of groundwater extraction. Extracted groundwater is transferred by a piping system to a treatment facility located at the Philips OU where it is treated and discharged to surface water.

This FYR addresses environmental investigation and remediation activities conducted at the AMD and TRW sites and in the Offsite OU.

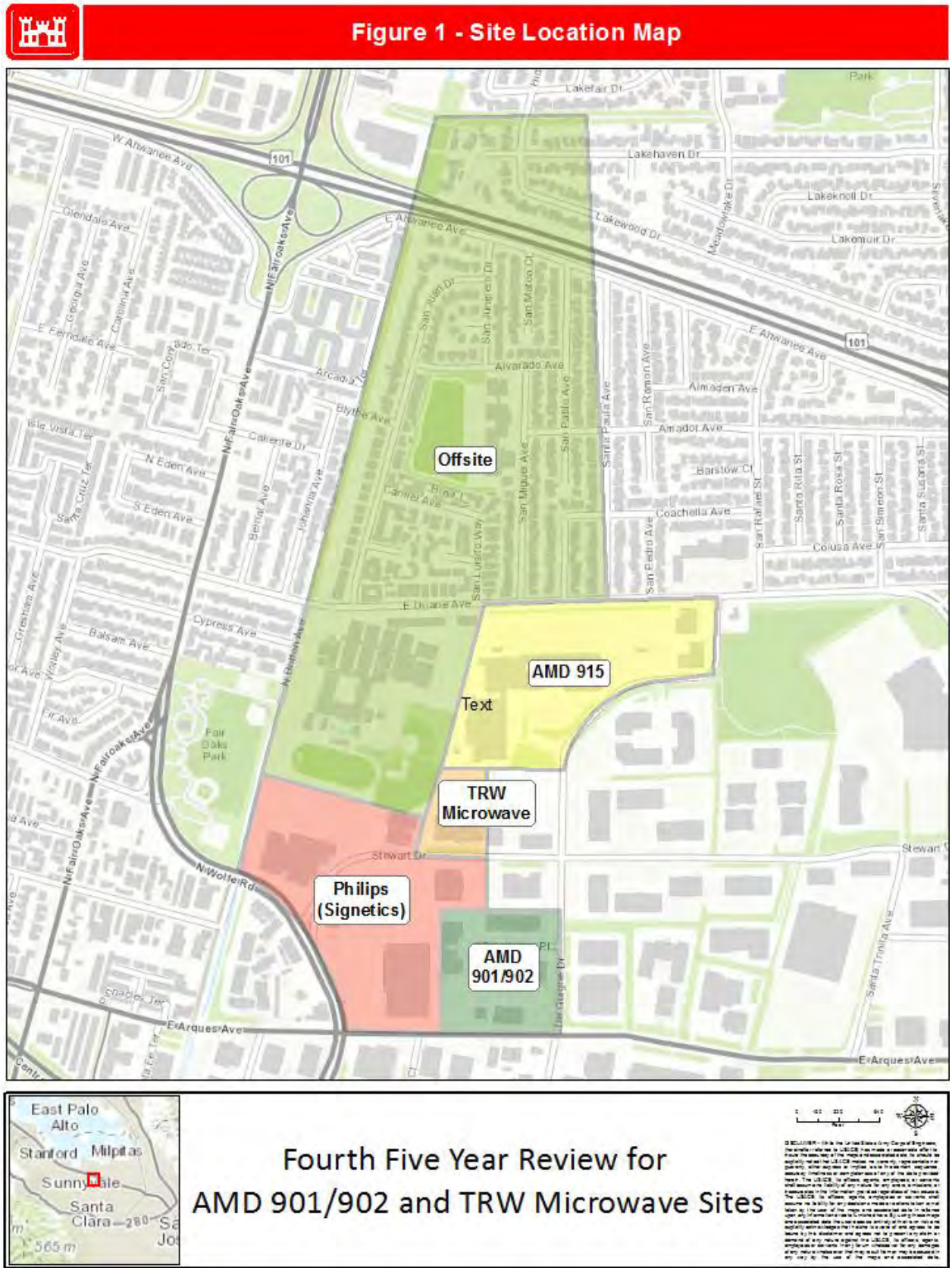

Figure 1. Locations of Operable Units at and near AMD 901/902 and TRW Superfund Sites

2. Site Chronology

Tables 1 - 3 list the dates of important events for the AMD, TRW, and Offsite OUs, respectively.

Table 1. AMD Chronology of Site Events

Event	Date
AMD begins semiconductor assembly at 901 Thompson Place	1969
AMD begins semiconductor assembly at 902 Thompson Place	1972
Soil and groundwater contamination discovered	1982
AMD removed acid neutralization systems and associated contaminated soils from both buildings	1983-1984
AMD began groundwater extraction and treatment	1984
Regional Board issued Waste Discharge Requirements Order	Sept 1985
Regional Board adopted Site Cleanup Requirements (SCR) order	Dec 1987
Site was listed on National Priorities List (NPL)	June 1986
Baseline Public Health Evaluation (BPHE) was completed	1990
Final Remedial Investigation/Feasibility Study (RI/FS) and Final Remedial Action Plan (RAP) were approved for AMD and adjacent TRW and Philips sites; Regional Board adopted Order #91-102 (Revised SCR)	June 1991
EPA issued Record of Decision (ROD)	Sept 1991
AMD stopped industrial operations at the site	1992
Regional Board and EPA completed first Five-Year Review (FYR)	Sept 1999
AMD submitted second FYR to Regional Board	Sept 2001
In-Situ Bioremediation (ISB) pilot project was initiated in former volatile organic compound (VOC) source area at 901 Thompson Place	Sept 2004
Regional Board and EPA completed second FYR	Sept 2004
AMD conducts additional subsurface investigation	April 2005
Ex situ granular activated carbon (GAC) treatment system and carbohydrate injection system installed.	Sept 2005
AMD began full-scale ISB program	Dec 2005
AMD sold the site property	2005
Onsite structures demolished by new owner	2006
A single large building was constructed for use as a self-storage facility and the address was changed to 875 East Arques Ave	2007
Ex situ treatment system reduced to one GAC vessel	Jan 2008
Regional Board issued No Further Action (NFA) letter for soil remediation	May 2008
The ISB program was converted from active to passive with quarterly monitoring and intermittent active periods	May 2008
Regional Board and EPA completed third FYR	Sept 2009
Focused Feasibility Study (FFS) completed	May 2011
Limited restart of ISB occurred	Oct 2011 – Feb 2012
Carbohydrate addition and groundwater recirculation restarted	November 2012 - present
Indoor air vapor intrusion investigation conducted	2013
Revised FFS completed	Sept 2013
Site is transferred from Regional Board to EPA Region 9, together with other Triple Site OUs.	Aug 2014

Table 2. TRW Chronology of Site Events

Event	Date
Aertech Industries began microwave and semiconductor assembly and testing at Site	1968
TRW acquired the property from Aertech Industries; no change in operations	1974
Soil and groundwater contamination discovered at Site	1983
Regional Board issued Cleanup and Abatement Order	June 1984
TRW removed underground solvent storage tanks and acid waste sumps and piping, and excavated soils	1984
TRW began groundwater extraction and treatment system (GWETS) operation	1985
FEI Microwave acquired the property from TRW and continued operations	1987
Regional Board adopted Site Cleanup Requirements (SCR)	Jan 1988
Baseline Public Health Evaluation (BPHE) completed for Site	1990
Site is listed on National Priorities List (NPL)	Feb 1990
Final RI/FS and Final RAP were approved for AMD, TRW, and Philips sites; Regional Board adopted Order #91-103 (Revised SCR)	June 1991
EPA issued Record of Decision (ROD)	Sept 1991
Industrial operations ceased at Site	1993
Regional Board and EPA completed first FYR review	Sep 1999
TRW suspended groundwater extraction in the former source area and initiated Enhanced Anaerobic Bioremediation (EAB) project in Zone B1 aquifer in former source area	Oct 2000
TRW suspended groundwater treatment throughout the Site	Apr 2001
EAB expanded to Zone A	Jun2001
Northrup Grumman purchased TRW and the Site	Dec 2002
CDM sampled indoor air for VOCs and evaluated Vapor Intrusion (VI)	Oct 2003
Regional Board approved re-designation of Site well 36D as a Zone A well rather than a Zone B1 well; Northrup Grumman sold Site to Pacific Landmark, LLC	Aug 2004
Regional Board and EPA complete second FYR	Sept 2004
Indoor air sampling conducted without mechanical ventilation system in operation	Oct 2004
EAB pilot program expanded to include groundwater immediately down-gradient of the former Site source area (around wells T-8A, T-8B, and T-10B)	Aug 2005
EAB expanded (4 new Zone A wells; 1 new Zone B1 well)	Sep 2005
Down-gradient Zone A EAB treatment area expanded (7 new injection wells; 1 new monitoring well)	Aug 2007
Cheese whey injected into down-gradient Zone A wells	Sept 2007 – June 2008
Regional Board and EPA complete third FYR	Sept 2009
GWETS dismantled and removed, and trenches filled with concrete	Nov 2012
Regional Board issued requirement for VI investigation	Dec 2012
Expanded source area investigation conducted	July 2013
Indoor air and sub-slab vapor sampling conducted showing screening level exceedances, with subsequent mitigation work ongoing	Dec 2013 - present
Site is transferred from Regional Board to EPA Region 9, together with other Triple Site OUs.	Aug 2014

Table 3. Offsite OU Chronology of Site Events

Event	Date
Duane Avenue extraction system began operation	1986
Carmel Avenue, Alvarado Avenue, and Ahwanee Drive extraction systems began operation	1988
Baseline Public Health Evaluation (BPHE) was completed for the combined sites	1990
Regional Board issued Site Cleanup Requirements to AMD, TRW, and Philips	1991
EPA issued Record of Decision (ROD)	Sept 1991
Additional wells installed in Carmel, Alvarado, and Ahwanee subsystems	1992
Philips voluntarily initiated indoor air evaluations at a high school and elementary school on Duane Avenue which overly the highest concentrations of TCE in shallow-zone groundwater	2004
Groundwater extraction conveyance changed from the AMD 915 DeGuigne Drive Superfund site to the Arquez site treatment system at the Philips OU	Oct 2010
Regional Board issued requirement for VI sampling work plan	Jan 2014
Site is transferred from Regional Board to EPA Region 9, together with other Triple Site OUs.	Aug 2014

3. Background

3.1. Physical Characteristics

The AMD site, TRW site, and Offsite OU are clustered together on relatively flat land south of San Francisco Bay in Sunnyvale, California (Figure 1).

The AMD site boundary, as defined in the ROD, includes the location of two former large, low-rise industrial buildings connected by a hallway (formerly 901 and 902 Thompson Place) and extends east to DeGuigne Drive (Figure 2). As defined, the AMD site includes seven other commercial buildings; however, these seven buildings do not overlie groundwater impacted by former AMD operations. Groundwater impacted by VOCs beneath these buildings appears to be attributable to off-site, up-gradient sources. Currently, a self-storage warehouse built in 2007 occupies the footprint of the former 901 and 902 Thompson Place buildings.

The former TRW Microwave site is located to the north of the AMD Site, also in a topographically flat area of the Santa Clara Valley. The on-site building has been vacant since January 2001. Between 2001 and 2003, the building's exterior was remodeled. As part of this remodeling, a portion of the building was demolished and a new structure, contiguous with the remaining portion of the existing building, was constructed (Figure 3). The building remained unoccupied for the duration of this FYR.

The Offsite OU extends north from the AMD and TRW Sites and represents the largest OU in spatial extent. The Offsite OU was originally mapped to encompass a single commingled groundwater contaminant plume composed primarily of dissolved trichloroethylene (TCE). The Triple Site includes the largest residential neighborhood of all of the National Priorities List (NPL) sites in the South Bay under the oversight of the State of California. Further, it includes a high concentration of sensitive populations, including an infant daycare and pre-school, two elementary schools and one high school, as well as a residential area of over 100 homes.

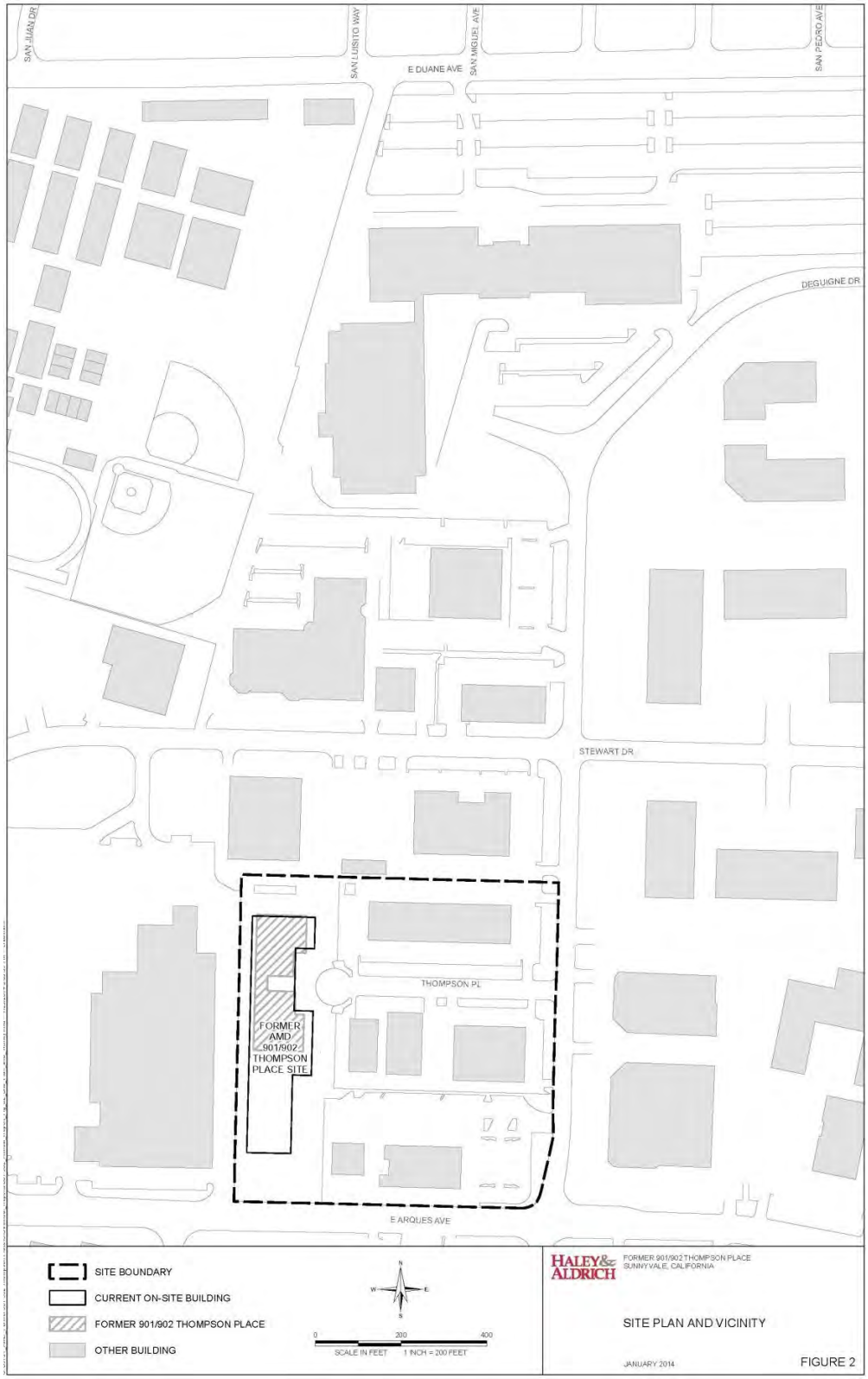

Figure 2. Locations of the former 901 and 902 Thompson Place buildings and the newer building in the same location

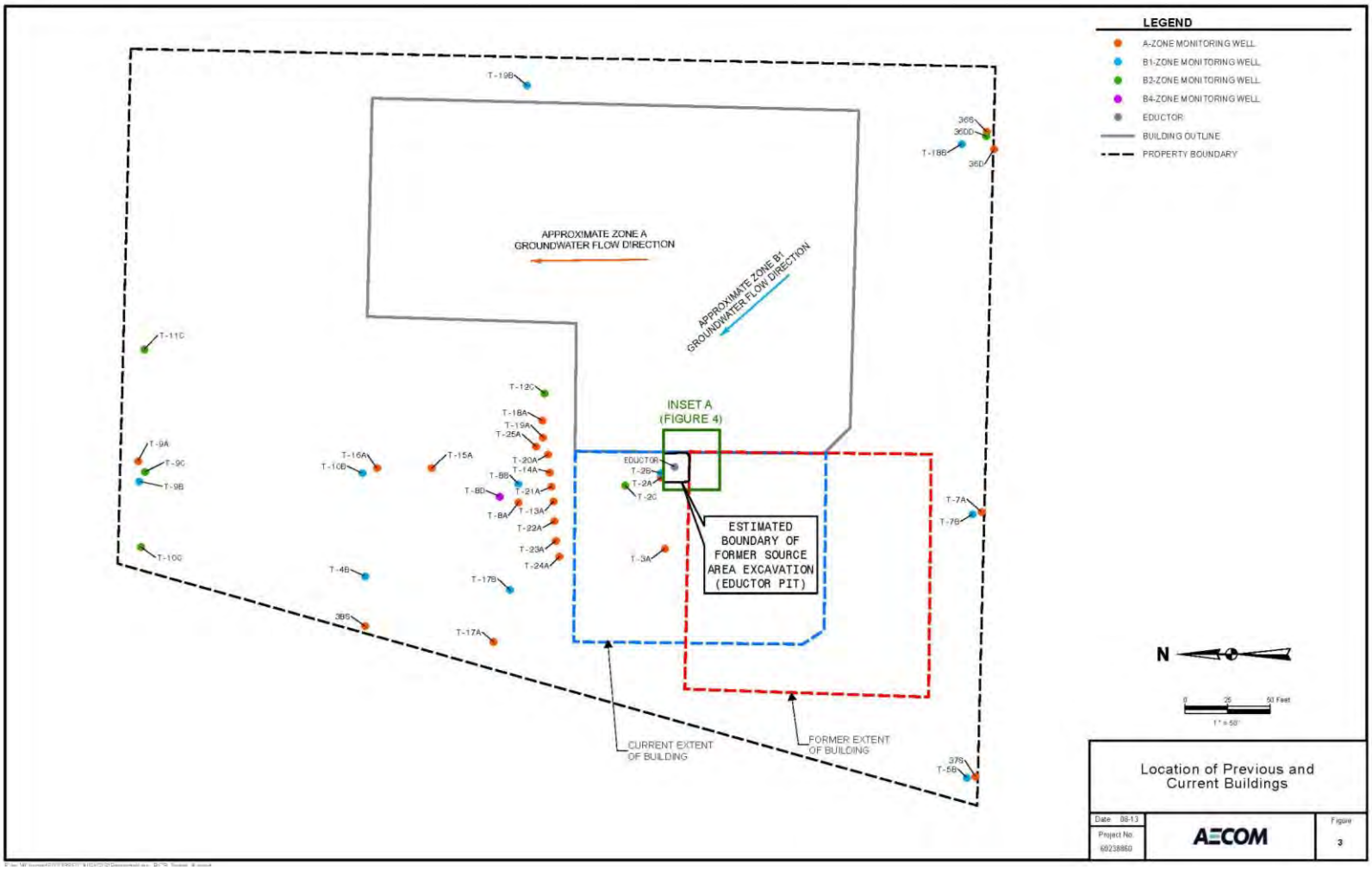

Figure 3. Location of the former building on the TRW Superfund Site and the current building extent in the same location

3.2. Hydrology

All three OUs are located in the Santa Clara Valley, a structural groundwater basin bounded by the Santa Cruz Mountains to the south and west and San Francisco Bay to the north. The basin is filled with alluvial sediments that were derived from the Santa Cruz Mountains and deposited along northward-trending ancestral streams en route to San Francisco Bay. The depositional environment was characterized by meandering and braided stream systems that created sequences of coarse-grained sand and gravel units inter-bedded with fine-grained clay and silt.

The alluvial sediments in the area have been regionally divided into two broad hydrogeological intervals or zones, referred to as the Upper Aquifer Zone and the Lower Aquifer Zone. These two zones are separated by a relatively impermeable aquitard which begins about 100 feet below ground surface. Below the aquitard at depths greater than 200 to 300 feet below ground surface (bgs) lies an extensive, deep regional confined aquifer, some wells from which are used for municipal water production. However, drinking water for this part is Sunnyvale is supplied by the Santa Clara Valley Water District (SCVWD) from a remote source – the Hetch Hetchy Reservoir in the Sierra Nevada Mountains, and meets all state and federal drinking water standards (see additional discussion, below).

Above the aquitard lies a complex series of laterally discontinuous aquifers and aquitards that can extend up to within a few feet of the ground surface. The natural groundwater flow direction beneath the Triple Site is to the north towards San Francisco Bay.

Several major water-bearing units have been characterized in the Upper Aquifer Zone at the combined sites. These coarse-grained, transmissive units are generally composed of sand or sandy gravel and are separated by layers of low permeability material (i.e., clay to silty sand). There is some degree of hydraulic connection between the water-bearing units due to the discontinuous nature of the sediment types. The first encountered water-bearing unit, called the A zone, is found from about 5 to 25 feet bgs. The next water-bearing unit encountered is the B1 zone which is found from about 30 to 45 feet bgs. The B2 zone is typically found between 45 and 70 feet bgs. The B3 zone is generally found between 70 and 90 feet bgs. The B4 zone starts below the B3 zone and is found from approximately 90 to 110 feet bgs. Below the B4 zone lies the B5 zone. Groundwater contamination at the AMD and TRW OUs extends down to B2 zone. Limited groundwater contamination is also present in the B3 and B4 zones of the Offsite OU.

The shallow water-bearing units underlying the combined sites are not used as a municipal drinking water source. The City of Sunnyvale owns, operates, and maintains eight deep municipal wells located throughout the City. The municipal wells are used to supplement imported water supplies to aid in meeting peak demands in the summer months and during emergency situations. The City of Sunnyvale uses three different sources of drinking water supply: local groundwater, treated surface water from the SCVWD (including from the Hetch Hetchy Reservoir in the Sierra Nevada Mountains), and treated surface water from the San Francisco Public Utilities Commission (SFPUC).

3.3. Land and Resource Use

3.3.1. AMD

Prior to the late 1960s, land use in Santa Clara County was agricultural, predominantly commercial fruit orchards. Industrial operations began at the AMD site in 1969, when AMD began manufacturing printed circuit boards and semiconductors at 901 Thompson Place. AMD began operations at 902 Thompson Place in 1972 and operated the combined facility until 1992. Operations were continuous with no significant process changes between 1969 and 1992.

AMD discontinued operations and vacated the two buildings in 1992. The Site was sold to Westcore Thompson II, LLC in 2005; the Site was later transferred to Summit Commercial Properties, Inc. (Summit). Summit demolished the buildings in 2006 and built the existing self-storage warehouse on the site in 2007; the site address was also changed from 901/902 Thompson Place to 875 East Arques Avenue at this time. The area immediately surrounding the property is light commercial with a mix of residential properties.

3.3.2. TRW

Industrial operations began at the TRW Site in 1968, when Aertech Industries began assembling and testing microwave and semiconductor components. In 1974, TRW acquired the site from Aertech and continued similar operations. In 1987, FEI Microwave purchased the site from TRW; FEI Microwave subsequently became Tech Facility 1, Inc. FEI Microwave operated the facility until 1993. Operations were continuous with no significant process changes between 1968 and 1993. In 1995 the site was acquired by Stewart Associates and subsequently leased to Diablo Research Corporation and Cadence Inc. for research and development operations. In 2001, the site building was remodeled, but the improvements were unfinished; the site building has remained unoccupied since 2001.

In 2002, TRW merged with Northrup Grumman. In 2004, the property was purchased by Pacific Landmark. The property ownership changed again in May 2014; the new property owner is Hines. During these changes in site ownership, TRW, and then Northrop Grumman, retained responsibility for the site cleanup. The area immediately surrounding the property is light commercial with a mix of residential properties.

3.3.3. Offsite Operable Unit

The Offsite Operable Unit (Offsite OU or OOU) is primarily a residential neighborhood consisting of single-family and multi-family homes, and includes 4 schools. The Offsite OU does not contain any buildings or properties from which the former Companies (AMD, TRW, and Philips/Signetics) caused soil and groundwater contamination through their industrial operations. Directly to the north and down-gradient of the AMD, TRW, and Philips OUs is the former high school for the City of Sunnyvale, which was used until the early 1980s. Subsequently, the school was leased for a number of years to house an engineering center. Currently, the buildings at the 790 East Duane Avenue property are occupied by the daycare/elementary school. Adjacent to this property are a preschool and daycare and a high school, and within the approximate center of the Offsite OU is an elementary school.

3.4. History of Contamination

3.4.1. AMD

AMD operated the AMD site continuously between 1969 and 1992. During this time, TCE and other industrial solvents were used for cleaning and degreasing, although TCE use reportedly ceased circa 1979. Acids were used for etching and caustics were used for acid neutralization. Acid neutralization systems (ANS), including in-ground sumps, were used at both AMD buildings between 1969 and 1984. Related hazardous wastes generated from these various operations were stored on-site.

In 1982, leakage from an acid neutralization sump at 901 Thompson Place initiated site investigations. Later, the ANS sump in building 902 was also found to be leaking. Additional studies of groundwater contamination in the 1980s identified chlorinated volatile organic compounds (VOCs), primarily TCE and its biodegradation products, cis-1,2-dichloroethylene (cDCE) and vinyl chloride in the upper 65 feet under the Site. The maximum historical TCE concentration found in groundwater was 110,000 µg/L at well 28-S, located near the neutralization tank adjacent to the former 902 Thompson Place building.

3.4.2. TRW

Operations at the site between 1968 and 1993 used TCE and several other industrial solvents and hazardous compounds; hazardous wastes were generated as a by-product of the operations. Waste solvent composed mainly of TCE was stored in an underground storage tank (UST) from 1970 through 1982. The tank was removed in early 1983. An in-ground, three-stage, ammonia gas ANS also operated from 1968 to 1984, when it was disconnected and removed; it was replaced by an aboveground system with secondary containment. The aboveground ANS was subsequently disconnected and removed in 2001, during remodeling of the site building.

TRW initiated an investigation of potential impacts to soil and groundwater at the site following the removal of the UST. Between 1983 and 1986, several subsurface investigations were conducted in the vicinity of the former areas of the UST, the ANS, and associated piping. The investigations identified VOCs as the only chemicals of concern at the site and the former UST area as the only source of VOCs impacting site groundwater.

Groundwater contamination from this site, consisting primarily of TCE and related chlorinated VOCs (cDCE and vinyl chloride [VC]), commingles with similar discharges from the adjacent Philips and AMD 901/902 Thompson Place sites. VOCs in groundwater at TRW are limited to water-bearing units in the upper 60 feet that are not used for public water supply.

The highest concentrations of contaminants exist in the A zone and B1 zone aquifers. The maximum historical TCE concentration in groundwater was 6,100,000 µg/L in August 1983 at A zone well T-2A, located near the former underground storage tank area.

3.4.3. Offsite OU

In the 1980s, investigations began in the groundwater north of Duane Avenue to determine the vertical and horizontal extent of chemicals at the OOU. Chemicals were discovered in groundwater, but were not

observed in the soil at the OOU. Due to the lack of potential sources in the area, the sources for the observed chemical concentrations were attributed to the manufacturing facilities located up-gradient of the area. This commingled plume is also referred to as the "Companies' Offsite Operable Unit" and is approximately 4,000 feet long and extends beyond Highway 101 to the north. Chemicals of concern in the plume are primarily chlorinated VOCs, of which TCE is the predominant chemical present.

3.5. Initial Response

3.5.1. AMD

Interim remedial action at the AMD site began in 1983 with the removal of the ANS and about 103 cubic yards of soil from AMD 901. Due to the proximity of the building not all of the contaminated soil could be removed from the southern portion of the excavation. In 1984, the acid waste neutralization sump and about 114 cubic yards of soil were removed from the vicinity of Building 902. The highest soil concentrations were found near AMD 901. Operation of the groundwater extraction and treatment system (GWETS), including excavation dewatering, began in 1984. Additional extraction wells were installed in 1988 to enhance containment of the groundwater pollution in the aquifer B2 zone.

The AMD site was officially included on the National Priorities list (NPL) in June 1986. A Baseline Public Health Evaluation (BPHE) was submitted in 1990. A Remedial Investigation/Feasibility Study (RI/FS) and Remedial Action Plan (RAP) were completed in June 1991. The Regional Board adopted the final Site Cleanup Requirements (SCR) Order No. 91-102 that same month. Shortly thereafter, on September 11, 1991, EPA issued the combined ROD for the AMD 901/902, TRW Microwave, Signetics (Philips), and Offsite OUs. Manufacturing operations at the AMD site ceased in 1992.

3.5.2. TRW

Remedial action at the site began in 1983 with the removal of the UST and some associated contaminated soil. In 1984, TRW excavated additional soil that was not removed with the UST. Due to the proximity of the excavation to the foundation of the 825 Stewart Building, not all of the contaminated soil could be removed. In total, TRW excavated and removed approximately 200 cubic yards of VOC-impacted soil. The excavation was approximately 19 feet by 16 feet in area, and extended to a depth of about 20 feet, terminating in a low permeability clay layer separating the A zone and the B1 zone. The excavation was backfilled with gravel to serve as a pit for groundwater extraction. A vertical polyvinyl chloride (PVC) pipe was placed in the gravel backfill pit, from the base of the pit to the surface, for groundwater extraction. The gravel backfill pit is identified as the Eductor pit and the PVC pipe as the Eductor (Figure 3). TRW began groundwater extraction and treatment in 1985.

The TRW Site was officially included on the NPL in February 1990. A Baseline Public Health Evaluation (BPHE) was submitted in 1990. An RI/FS and RAP were completed in June 1991. The Regional Board adopted the final Site Cleanup Requirements (SCR) Order No. 91-103 that same month. Shortly thereafter, on September 11, 1991, EPA issued the combined ROD for the AMD 901/902, TRW Microwave, Philips, and Offsite OU. Manufacturing operations at the TRW site ceased in 1993.

3.5.3. Offsite Operable Unit

Interim remedial actions at the OOU began in 1986 with the installation of the Duane Avenue extraction system. Three additional extraction systems (Carmel Avenue, Alvarado Avenue, and Ahwanee Drive) came online in 1988. An extensive groundwater sampling program was established around the same time.

A BPHE was submitted in 1990 for the combined sites. Although the Regional Board did not issue an SCR Order specific to the OOU, the remedy for the OOU is discussed in Order No. 91-102 (AMD 901-902), adopted in 1991. Shortly thereafter, on September 11, 1991, EPA issued the combined ROD for the AMD 901/902, TRW Microwave, Philips, and Offsite OUs.

3.6. Basis for Taking Action

The primary contaminant(s) of concern for the combined sites are chlorinated VOCs in soil (AMD, TRW) and groundwater (AMD, TRW, and Offsite OU). The ROD identified the following ten chemicals of concern (COCs) common to one or more OUs:

- 1,2-Dichlorobenzene (1,2-DCB)
- 1,1-Dichloroethane (1,1-DCA)
- 1,1-Dichloroethylene (1,1-DCE)
- cDCE
- Trans-1,2-Dichloroethylene (trans-1,2-DCE)
- Freon 113
- Tetrachloroethylene (PCE)
- 1,1,1-Trichloroethane (1,1,1-TCA)
- TCE
- Vinyl chloride (VC)

The presence of these contaminants in soil and groundwater provided the basis for taking action under CERCLA. The release of hazardous substances into the environment at the sites posed, or potentially posed, a threat to human health and the environment via inhalation, ingestion, and direct contact.

4. Remedial Actions

4.1. Remedy Selection

The combined ROD for AMD 901/902, Philips, and TRW Microwave was signed September 11, 1991 and addressed four operable units: AMD 901/902, Philips, TRW, and the Offsite OU. As mentioned previously, the Philips site was not listed on the NPL at the time of listing of the AMD 901/902 and TRW sites and is not discussed further in this section. However, the Philips site was transferred from the Regional Board to the EPA Region 9 Superfund Program on August 7, 2014, together with the other OUs that make up the Triple Site. The ROD identified 10 COCs in groundwater, all of which apply to the AMD and TRW OUs; a subset of which is applicable to the Offsite OU.

Table 2. Cleanup standards for the Groundwater COCs

Chemical	Cleanup Standard (µg/L)	Source	Applicable OU(s)
1,1-DCA	5	California (CA) MCL	AMD, TRW, Offsite
1,2-DCB	600	Federal MCL	AMD, TRW
cDCE	6	CA MCL	AMD, TRW, Offsite
tDCE	10	CA MCL	AMD, TRW, Offsite
1,1-DCE	6	CA MCL	AMD, TRW, Offsite
Freon 113	1200	CA MCL	AMD, TRW, Offsite
PCE	5	CA MCL	AMD, TRW, Offsite
TCE	5	CA MCL	AMD, TRW, Offsite
1,1,1-TCA	200	CA MCL	AMD, TRW, Offsite
Vinyl chloride	0.5	CA MCL	AMD, TRW

The ROD selected state Maximum Contaminant Levels (MCLs) for groundwater cleanup standards for 9 of the 10 COCs. Due to the lack of a state MCL, the cleanup level for the tenth COC (1,2-DCB) was set at the federal MCL.

No soil cleanup levels were selected in the ROD for any of the OUs.

4.1.1. AMD

The remedy selected in the ROD for the AMD OU consists of the following elements:

- Soil excavation followed by offsite incineration/disposal of the remaining contaminated soil beneath AMD 901;
- Continued groundwater extraction and treatment by air stripping;
- Groundwater monitoring; and
- Placement of a restrictive covenant prohibiting installation of onsite wells until groundwater remediation is completed.

4.1.2. TRW

The remedy selected in the ROD for the TRW OU consists of the following elements:

- Groundwater extraction;
- Treatment of extracted groundwater by air stripping;
- Discharge of treated water under a National Pollutant Discharge Elimination System (NPDES) permit; and
- Institutional controls, including restrictive and environmental covenants, which include prohibiting residential land use, no extraction of groundwater, and continued monitoring of groundwater.

4.1.3. Offsite OU

The remedy selected in the ROD for the Offsite OU consists of the following:

- Expanded groundwater extraction;
- Treatment of extracted groundwater by air stripping (at the AMD 915 DeGuigne Drive facility);
- Reuse or discharge of the treated groundwater to surface water under an NPDES permit.

4.2. Remedy Implementation

4.2.1. AMD

In response to the 1991 SCR and ROD, an additional 94 cubic yards of soil was excavated from 901 Thompson Place in 1992, and of that, 40 cubic yards was determined to be contaminated. The contaminated soil was disposed of offsite, and the remainder was used as backfill. The Regional Board reviewed the relevant soil and groundwater sampling results for VOCs and issued a No Further Action (NFA) letter, dated May 14, 2008, to confirm the completion of site investigation and remedial actions for releases with respect to unsaturated zone (shallow) soil at the site. Shallow soil at the site is no longer considered a source for groundwater impacts.

Groundwater remediation is still ongoing at the site. The GWETS began operation in 1983 with three extraction wells, was expanded to a total of eight extraction wells in 1993, and continued operating through 2002. The GWETS was comprised of eight extraction wells (DW-1 through DW-8) which pumped water from the A, B1, and B2 zones to an on-site treatment system, where VOCs were removed from the extracted water by air-stripping prior to permitted discharge to the storm sewer or onsite reuse.

Although concentrations of VOCs associated with onsite releases decreased as a result of the GWETS operation, the rate of VOC concentration reduction was marginal and VOC concentrations remained considerably above cleanup standards during the final ten years of the GWETS operation. It is believed that VOCs stored in the low-permeability zones of the aquifer system cannot be readily flushed out, thus prolonging the cleanup time. Because of declining effectiveness of the selected remedy, a new remedy, ISB, was tested by the RP to accelerate site groundwater cleanup. Pilot testing for ISB began in 2002 and full-scale ISB commenced in 2005. During the pilot study, in which carbohydrate was injected into the groundwater to stimulate microbial processes, TCE, cDCE, and vinyl chloride concentrations were reduced in pilot test wells by over 90% within 6 months. Use of the GWETS as a groundwater circulation tool was also shown effective in distributing carbohydrate throughout the treatment zone.

Following the successful demonstration of the ISB pilot test, the responsible party (RP) expanded the ISB and integrated the GWETS to assist circulation. A network of extraction and injection wells was installed to distribute carbohydrate solution to coarse-grained depth intervals within the A, B1, and B2 zones. Figure 4 shows a recent layout of injection, extraction, and monitoring wells for the ISB program. Extraction wells are typically located near the down-gradient site boundary to reduce the potential for contaminated groundwater to reach and impact down-gradient properties whereas injection wells are generally up-gradient of the previously reported former VOC source area at the 901 site. Injection and

extraction well assignments are not permanent; injection and extraction locations are rotated in order to improve lateral distribution of the carbon substrate. Carbohydrate injection is performed by injecting a solution of carbohydrate-amended water that has been extracted from down-gradient wells after *ex situ* treatment with granular activated carbon (GAC).

An environmental covenant prohibiting residential land use, groundwater well installation and soil excavation was recorded for the Site in 2005. Current status of institutional controls is discussed in Section 6.7.

In September 2013, a revised Focused Feasibility Study (FFS) was completed that evaluated groundwater extraction and treatment, ISB, monitored natural attenuation (MNA), and a permeable reactive barrier as potential revised remedies for the site. The FFS did not address the vapor intrusion pathway.

4.2.2. TRW

Interim actions began in 1983 with the removal of the underground waste solvent storage tank and some associated contaminated soil. Additional soil was removed from this same area in 1984. Due to the proximity of the excavation to the foundation of the 825 Stewart Building, not all of the contaminated soil could be removed. A total of 120 cubic yards was removed.

The GWETS and groundwater monitoring program were fully implemented at the time the final SCR and ROD were adopted in 1991.

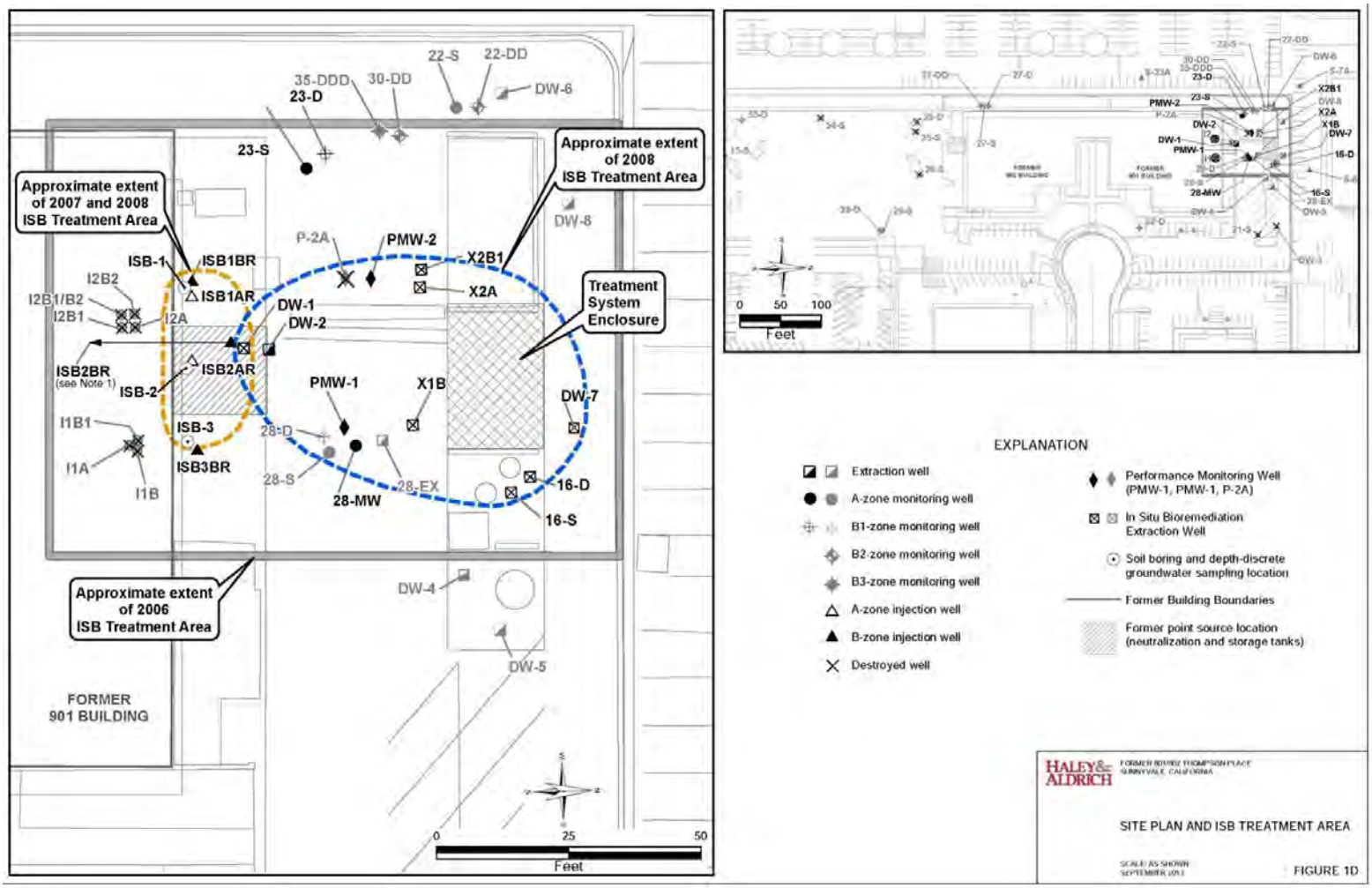

Figure 4. A recent layout of ISB injection, extraction, and monitoring wells

Following the signing of the ROD in 1991, TRW began soil vapor extraction and treatment (SVET) in July 1993 to enhance cleanup in the unsaturated zone in the vicinity of the former UST area. The SVET system operated full-time through November 1996. Rebound testing was conducted in September 1997 and July 1998, during which time groundwater VOC concentrations decreased to 5 parts per million or lower except for one extraction point in the former UST location. In August 1998, TRW demonstrated that the site-specific soil cleanup criteria had been met and received permission from the Regional Board to terminate soil remediation. The SVET system removed approximately 140 pounds of TCE. The SVET system was removed in November 1998 and the Regional Board issued a letter stating that the SVET system had achieved the soil cleanup level (1 mg/kg total VOCs) and no further action was required in the vadose zone.

In 1998, TRW concluded that the GWETS was reaching its technical limitations. Decreases in TCE concentrations were most dramatic during the first five years of system operation (1985 to 1990). During the 1990s, the TCE concentrations appeared to have reached near asymptotic levels. In 2000, the TCE mass removed was only 30 percent of that removed in 1985, and in 2001, the Regional Board approved permanent suspension of groundwater extraction.

The GWETS was shut down in the source area in October 2000 to allow an enhanced anaerobic biodegradation (EAB) treatability study, and complete GWETS shut down occurred in April 2001. At the request of the current property owner, Pacific Landmark, LLC, the above-ground GWETS components were dismantled and removed in November 2012. The eight wells originally designed for use in the GWETS remain in use for groundwater monitoring and are part of a 42-well on-site monitoring well network.

To address high concentrations of VOCs in groundwater near the on-site source area outside of the excavation, TRW initiated EAB injections and testing in October 2000. Hydrogen Release Compound (HRC) was initially injected into source area B1 zone wells. A follow-up injection of HRC into A zone and addition B1 zone wells occurred in June 2001. Following a successful pilot program, the EAB program was expanded in 2005 to include the area immediately down-gradient of the former source area.

Targeted source area remedial activities were performed in October and November 2010; emulsified vegetable oil (EVO) and neat vegetable oil were injected into the Eductor between 2007 and 2008 to generate reducing conditions and to sequester chlorinated VOCs within the neat oil introduced into the pea gravel-filled excavation. Following the Eductor injections, two additional carbon substrates, EHC-L and ABC+, were injected down-gradient of the former site source area in November 2011. Since then, no further EAB-related injections have been performed. Figure 5 summarizes the EAB and other remedial activities that have occurred at the TRW OU.

Since 2000, the network of extraction and injection wells has expanded several times. The current locations of monitoring wells for the EAB program are shown in Figure 3. Figure 5 shows which wells are or have been used for injection and extraction. Extraction wells are generally installed near the down-gradient site boundary to reduce the potential to impact down-gradient properties. Injection wells are generally installed up-gradient of the former VOC source area. Annual groundwater monitoring continues at the site.

Due to declining effectiveness of the groundwater extraction and treatment portion of the remedy, the RP proposed enhanced anaerobic biodegradation (EAB) as a revised remedy for groundwater. Pilot testing for EAB began in 2000 and was expanded in 2005. A draft FFS was completed in 2011 that evaluated several remedies, including groundwater extraction and treatment, EAB, institutional controls (ICs), MNA, and in-situ chemical oxidation. This draft FFS did not evaluate the vapor intrusion pathway. The final FFS has not yet been released.

4.2.3. Offsite OU

As of 2012, twenty-nine extraction wells are operating at the OOU. The wells are clustered into four parallel groups, based on location. From south to north, the well groupings are Duane Avenue, Carmel Avenue, Alvarado Avenue, and Ahwanee Drive (Figure 6).

The Duane Avenue extraction well cluster includes nine extraction wells with at least one well in each of the Upper Aquifer A, B1, B2, B3, and B4 zones. This portion of the groundwater extraction system began pumping in November 1986. To the north of the Duane Avenue group lies the Carmel Avenue subsystem, which was installed in 1988 and augmented in 1992. The Carmel Avenue group includes five wells distributed among the A, B1, and B2 zones. The Alvarado Avenue subsystem consists of 10 wells across the A, B1, and B2 zones. These wells were installed in 1988 and 1992. The fourth and northernmost line of extraction wells lies along Ahwanee Drive and consists of five wells in the A, B1, and B2 zones. These wells were also installed in 1988 and 1992.

Until October 2010, groundwater from all the OOU extraction wells was conveyed to a treatment system located on the northern side of the building at 915 DeGuigne Drive. The influent groundwater at this facility was first treated using two packed tower air stripper units plumbed in parallel.

In October 2010, groundwater extracted from the OOU was permanently diverted to the treatment system at the Philips site at 440 North Wolfe Road (813 Stewart Drive). The Philips treatment system also treats groundwater extracted from the Philips OU.

The Philips treatment system uses an ultraviolet (UV) oxidation system as the primary treatment method. The designed system is sized to remove 100% of the influent concentrations of those compounds. The UV system is also partially effective for Freon 113. A secondary treatment process of air stripping follows the UV system. The exhaust from the air stripper is vented to the atmosphere. After these two processes, the treated effluent is discharged to the Sunnyvale East Channel in accordance with NPDES Permit No. CAG912003, Order No. R2-2009-0059.

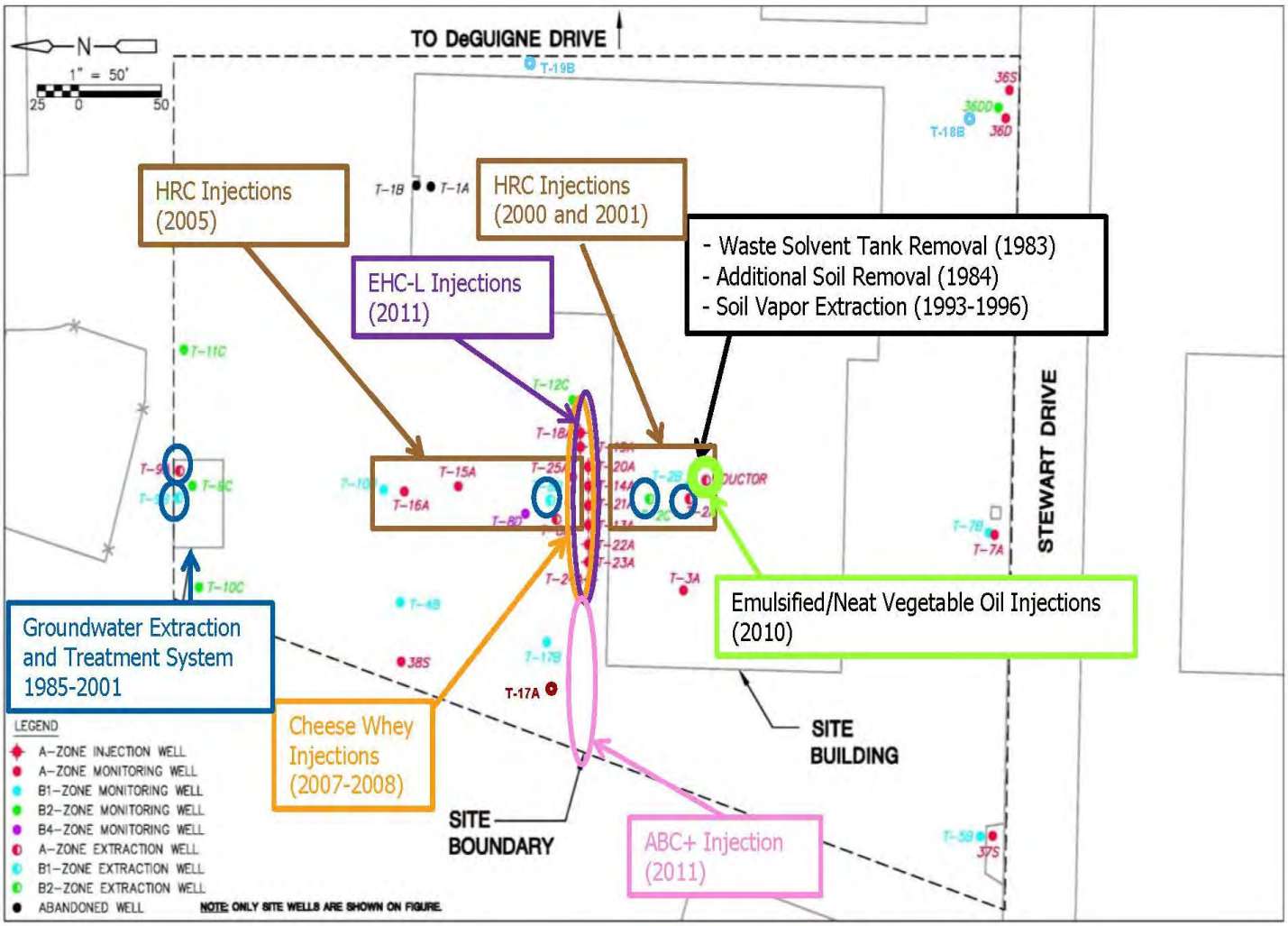

Figure 5. EAB and other remedial activities at the TRW OU

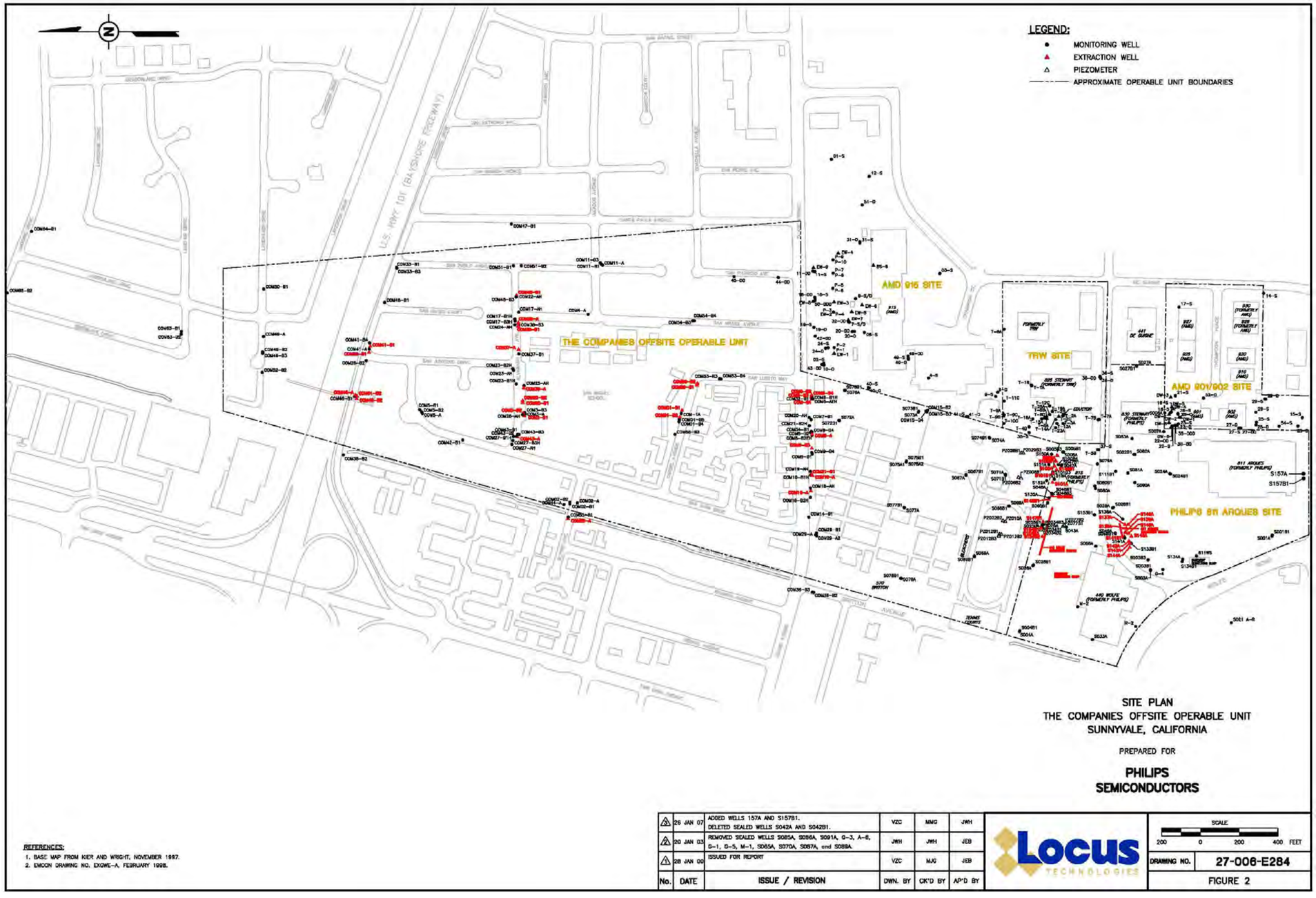

Figure 6. Offsite OU well locations

4.3. Operation and Maintenance

4.3.1. AMD

Surface maintenance of the Site is the responsibility of the current property owner, Summit Commercial, Inc. Until recently, maintenance of the ISB treatment system and associated extraction, injection, and monitoring wells was performed by AMEC, AMD's contractor. Starting in 2013, AMD has a new contractor, Haley & Aldrich, Incorporated (HAI) that conducts the environmental work.

The 2013 annual monitoring report indicates that the following operations and maintenance (O&M) activities occur on the Site, as performed by AMD's contractor:

- Weekly site visits;
- Monthly system inspections;
- Sampling of influent groundwater streams from the operation extraction wells and influent and effluent sampling from the GAC vessels for analysis of VOCs and TOC. Extraction wells are also analyzed for dissolved hydrocarbon gases.
- Routine maintenance such as servicing extraction pumps and management of carbohydrate storage tote; and
- Adjustment of extraction and injection configurations to optimize distribution of carbohydrate.

The full-scale ISB Workplan and ISB Implementation Plan were reviewed to determine if other O&M requirements may exist (Geomatrix, 2005; Geomatrix, 2006). Both documents specify monthly system inspections, monthly sampling of influent and effluent treatment streams, routine maintenance of pumps and rainwater removal, GAC change-out if needed, and management of the carbohydrate delivery system.

Extracted groundwater is treated on-site with two GAC vessels operating in series (one lead vessel and one lag vessel) to remove VOCs prior to carbohydrate addition and re-injection. Discharge to storm sewers no longer occurs. The last documented GAC change-out occurred in 2006 for the lag vessel; no documented change-outs have occurred since then. In 2008, the lag vessel was reportedly disconnected, leaving only the lead vessel in place. During the fall 2013 site visit, the current site contractor (Haley & Aldrich) explained that current practice is to have two GAC vessels in series when the ISB is operating. No contamination (breakthrough) was observed in any of the treated effluent measurements from the GAC vessels taken during the short periods when ISB was in active mode in 2011 or 2012.

Active ISB, which consists of carbohydrate injection and concurrent GWETS operation, occurred between December 2005 and May 2008, at which point the ISB was converted to passive mode (except for short periods in active mode). In passive mode, carbohydrate injection does not occur, but bioremediation is assumed to continue due to accumulated presence of carbohydrate source in the groundwater following injection. Additional carbohydrate injection and groundwater circulation resumed October 2011 following observations of higher VOC concentrations in wells where total organic carbon was depleted. Carbohydrate injection was discontinued in January 2012, but recirculation was allowed to continue until the end of February. Carbohydrate injection and recirculation was resumed November 2012 through February 2013, after which the system was again returned to passive mode and remains in

passive mode at present. During the December 2012 thru February 2013 period of active operation, the average flow rate for the ISB system for the A and B zone aquifers was reported at 0.71 gallons per minute.

Since ISB activities began in December 2005, approximately 13 pounds of COCs have been removed by the GAC vessels. Annual estimates of VOCs removed by the GAC vessels has declined from a high of 5.9 pounds in 2006 (the first full year of GAC operation) to a low of 0.7 pounds in 2013. Extraction efficiency of the ISB groundwater extraction system remains greater than the previous GWETS plus air-stripping treatment that was discontinued in 2002. VOC-mass removal methods, volumes, and efficiencies are summarized in Table 3. Estimated VOC mass removal solely by *in situ* treatment is unavailable.

Table 3. AMD 901/902 Site Estimated VOC Mass Removal Methods, Volumes, and Efficiency

Method	Volume Extracted (gallons)	Average Influent VOCs (µg/L)	Estimated Total VOCs Removed (pounds)	Extraction System Efficiency (lbs/MG)
Historical Groundwater Extraction				
1984 – 1995	126,940,000	529	559	4.4
1996	16,140,000	283	38	2.4
1997	15,817,920	339	45	2.8
1998	16,636,170	277	38	2.3
1999	16,170,000	251	31	1.9
2000	12,291,830	262	27	2.2
2001	13,032,970	281	29	2.2
2002	13,495,145	363	40	2.9
Subtotals/Average	**230,524,035**	**414**	**809**	**--**
ISB Groundwater Extraction with GAC Treatment				
2006	586,929	1,287	5.9	10.0
2007	154,649	2,653	3.0	19.5
2008	291,553	539	1.3	4.5
2011	109,204	1,113	1.0	9.3
2012	205,125	761	1.3	6.3
2013	**114,370**	**721**	**0.7**	**6.0**
Subtotals (2006-2013)	**1,461,830**	**1,179**	**13**	**11.0**
Total	**231,985,865**	**7,065**	**832**	**3.5**

Notes: Table adapted from Haley & Aldrich, 2013c. Lb/MG=pounds VOCs removed per million gallons of extracted water.

Groundwater is sampled annually in approximately 20 wells. ISB groundwater monitoring occurs quarterly in approximately 10 wells. Groundwater elevation data is collected concurrently with groundwater sampling. Figure 7 provides the current layout of both ISB-specific and general monitoring wells at the AMD OU.

Estimates for the annual O&M cost varied depending on the information source. During the site visit, the site contractor, Haley & Aldrich, estimated $25,000-30,000 for annual O&M costs. Subsequent email communication with the Regional Board provided a higher estimate of approximately $35,000 per year. The cost estimates include necessary sampling requirements and are expected to vary slightly from year to year based on several factors, such as carbon usage and necessary maintenance.

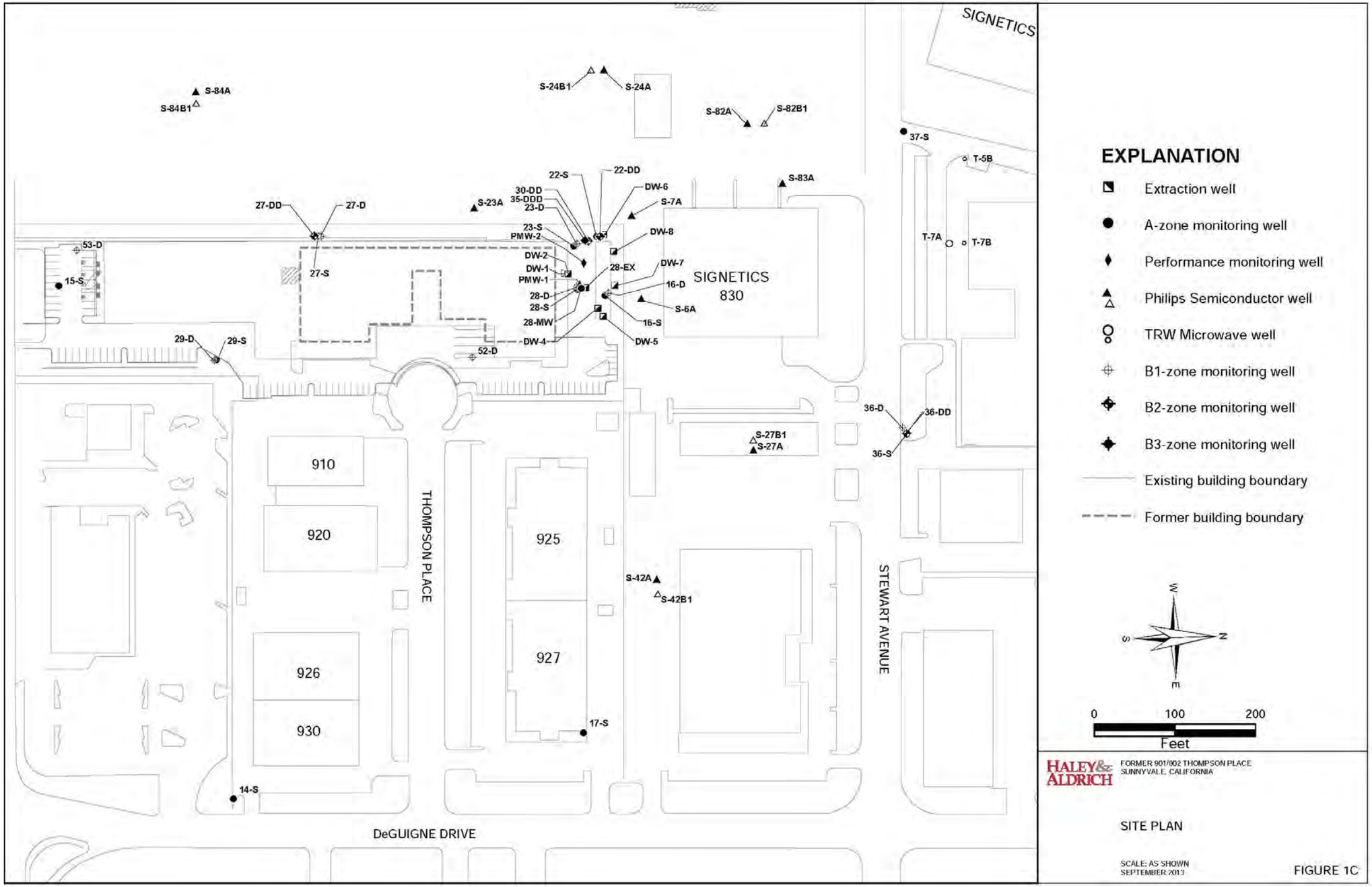

Figure 7. AMD OU monitoring wells

4.3.2. TRW

The GWETS has been suspended since 2001, but groundwater monitoring has continued on an annual basis across the Site and on a quarterly basis within the EAB treatment area since that time. Northrop Grumman, the Responsible Party (RP) for the Site, submits groundwater-monitoring reports annually to the Regional Board. The SVET system was shut down in October 2000.

EAB activities, such as injection of substrate (vegetable oil, EHC emulsion, and other chemicals) have been occurring once or twice a year on average. New injection wells for EAB substrate injection were installed in 2012.

Other non-recurrent activities include dismantling and removal of old equipment and the performance of various studies, such as the membrane interface probe (MIP) survey in 2013 (see Section 5.2.2).

The main costs associated with the TRW Site cleanup are sampling, analytical laboratory fees, site investigations, EAB treatment, consulting fees and reporting. These costs are summarized in Table 4.

Table 4. TRW Annual O&M costs for GWETS operation and EAB Treatment

From	To	Total Cost
Sept 1996	April 2001	$300,000
May 2001	May 2004	$301,000
June 2004	Dec 2008	$612,000
Jan 2009	Dec 2012	Unknown

4.3.3. Offsite OU

The Philips treatment plant is operated and sampled by Locus Technologies (Locus), a contractor for Philips Semiconductors. Annual NPDES reports produced by Locus summarize treatment system operations and issues. During 2013, the groundwater treatment system treated approximately 96.7 million gallons of water from the Philips and Offsite OU, with an average flow rate of approximately 183 gallons per minute (gpm). Approximately 345 kg of VOCs, consisting primarily of TCE and Freon 113, were removed in 2013 (Locus, 2014).

Except for short temporary shutdowns for routine maintenance and to fix minor repair issues, the treatment system was in continuous operation during 2013. No untreated groundwater was discharged during these shutdowns.

Treatment system effluent water samples are collected monthly by Locus. All 2013 effluent concentrations were within the NPDES permit requirements (Locus, 2014).

A selection of groundwater monitoring wells and extraction wells throughout the site from all aquifers are sampled annually by Locus. The annual groundwater sampling is coordinated with the surrounding Sites (AMD 915, AMD 901/902, TRW, and Philips) to provide a comprehensive regional data set for the area. Analysis of groundwater data for the OOU is presented in section 6.4.7.

Operation and maintenance costs for the OOU extraction well system and the Philips groundwater treatment system were unavailable.

5. Progress Since the Last Five-Year Review

5.1. Previous Five-Year Review Protectiveness Statement and Issues

5.1.1. AMD 901/902

The protectiveness statement from the 2009 FYR for the AMD 901/902 Site stated the following:

> *"The remedy at the Advanced Micro Devices, Inc. (AMD) Superfund site at 901/902 Thompson Place in Sunnyvale, California, is currently protective of human health and the environment as institutional controls are in place to prevent exposure to contaminated groundwater and there is no current exposure from vapor intrusion. To be protective in the long-term, a strategy should be developed to assess and address potential, future vapor intrusion risk if on-site building use changes, or if new buildings are constructed, and a new restrictive covenant should be recorded. Additionally, the ROD and final SCR will need to be amended to reflect the remedy change."*

The 2009 FYR included three issues and recommendations. Each recommendation and its current status are discussed below.

Table 5. Status of Recommendations from the 2009 AMD 901/902 FYR

Issues from previous FYR	Recommendations	Action Taken and Outcome	Date of Action
1. In-situ bioremediation has shown greater potential towards achieving site cleanup standards in a reasonable time frame than the GWETS.	AMD should continue to evaluate the progress of groundwater treatment and the ISB Program. The ROD and final SCR will need to be amended to reflect the remedy change from groundwater extraction to ISB.	A revised FFS was submitted to the Regional Board in 2013. A ROD amendment selecting a revised remedy has not yet been issued.	2013
2. If use at the building changes, or a new building is constructed, then there may be a potential for vapor intrusion until the groundwater remedy is successful.	AMD will be required to conduct soil gas sampling to further assess the potential vapor intrusion pathway. If the soil gas sampling results indicate a potential vapor intrusion concern (i.e., soil gas concentrations greater than soil gas environmental screening levels [ESLs]), AMD will be required to conduct indoor air sampling.	An indoor air evaluation was completed for the AMD site in 2013. The evaluation concluded that vapor intrusion is not an issue for the ROD contaminants of concern. The evaluation is discussed in more detail in Section 6.4.3.	2013
3. The existing restrictive covenant is not consistent with current state law (CA Civil Code section 1471) which establishes the framework for environmental covenants in California.	A restrictive covenant should be recorded for the Site that is consistent with current California law.	California Civil Code (CCC) section 1471 was passed in 1995 and amended in 2002.The current restrictive covenant for the AMD site was prepared in 2005 and should be consistent with current California law unless subsequent revisions have occurred.	NA

5.1.2. TRW

The protectiveness statement from the 2009 FYR for TRW stated the following:

"The remedy at the TRW Microwave Superfund Site in Sunnyvale, California is currently protective of human health and the environment. Current information indicates that the remedy may not be able to restore the groundwater to its beneficial use as a potential drinking water source. Enhanced Anaerobic Biodegradation (EAB) process is currently being tested at the Site. In the short-term, the institutional controls are preventing exposure to, and the ingestion of, contaminated groundwater. Additionally, while there currently is no exposure risk from vapor intrusion because the current building is unoccupied, the necessity of a restrictive covenant for vapor intrusion will be determined after a vapor intrusion assessment is completed which considers changes in the building's current or future use, and/or redevelopment of the building or Site. There is no exposure risk from vapor intrusion because the current building is unoccupied. The ROD and final SCR need to be amended."

The 2009 FYR for TRW identified two issues and recommendations. Each recommendation and its current status are discussed below.

Table 6. Status of Recommendations from the 2009 TRW FYR

Issues from previous FYR	Recommendations	Action Taken and Outcome	Date of Action
1. Operation of selected remedy ceased approximately 9 years ago. EAB is being evaluated.	Continue groundwater monitoring to assess the potential success of the EAB pilot testing. Evaluate alternatives to achieve Remedial Action Objectives in the groundwater. The ROD and final SCR need to be amended.	Groundwater monitoring has continued on a regular basis. A draft FFS was completed in 2011 that presents cleanup alternatives for the site; the document has been reviewed, but it has not yet been finalized. The ROD and SCR have not been amended.	2011
2. The existing restrictive covenant was recorded prior to the passage of the California Civil Code section 1471, which establishes the framework for environmental covenants in California.	The legal owners of the former TRW Microwave property should record a new restrictive covenant that is consistent with current California law.	A new covenant has not been recorded. The existing covenant recorded in 1992 is still in effect.	NA

5.1.3. Offsite OU

The Offsite OU was not previously evaluated in a FYR. No previous protectiveness statement or identification of issues and recommendation exist.

5.2. Work Completed at the Site During this Five Year Review Period

5.2.1. AMD

An FFS was completed in 2011 and subsequently revised in 2013 to evaluate remedial alternatives. The FFS conclusion proposes ISB coupled with MNA as the revised remedy for the site. In the interim, ISB continues to be implemented at the site to treat groundwater contamination. In March 2013, AMD also conducted indoor air sampling at the AMD site; an indoor air evaluation report was completed in February 2014.

On August 7, 2014 lead agency oversight responsibilities for the AMD site (as well as the other Triple Site OUs, including the Philips Site) was transferred from the Regional Board to the EPA Region 9 Superfund Program.

5.2.2. TRW

Additional EAB injections were accomplished until November 2011. In November 2012, the former Groundwater Treatment System was removed by Cornerstone Environmental, with oversight by AECOM, at the request of the current property owner. The system was dismantled and removed from the site, and the system piping trenches inside the building were filled with concrete (AECOM 2013a).

In July 2013, a membrane interface probe (MIP) survey was conducted; the report concluded that there is no evidence for remaining high-concentration VOC-impacted material in the vicinity of the original excavation, and therefore the contractor (AERCOM) would not move forward with additional EAB activities for now.

Indoor air and sub-slab gas samples were collected in December 2013 to re-assess vapor intrusion potential at the existing building; the data was published in February 2014 (see section 6.4.6).

On August 7, 2014 lead agency oversight responsibilities for the AMD site (as well as the other Triple Site OUs, including the Philips Site) was transferred from the Regional Board to the EPA Region 9 Superfund Program.

5.2.3. Offsite OU

In October 2010, the groundwater well extraction system was re-routed from the treatment system located at 915 DeGuigne Drive to the treatment system in the Philips OU. A revised NPDES permit application was approved to authorize this change in influent streams into the Philips treatment system.

Since 2004, indoor air sampling has been conducted annually at 790 East Duane Avenue, the site of a collection of buildings occupied by the daycare/elementary school. In a January 2014 letter to Philips, the Regional Board requested that the Companies submit a vapor intrusion evaluation work plan to conform to EPA Region 9 VI recommendations issued in December 2013. The requested VI work plan had not been completed during preparation of this FYR.

On August 7, 2014 lead agency oversight responsibilities for the AMD site (as well as the other Triple Site OUs, including the Philips Site) was transferred from the Regional Board to the EPA Region 9

Superfund Program. This transfer occurred following the expansion of the vapor intrusion investigation because of EPA's authorities, expertise, and resources for investigating potential vapor intrusion sites. EPA's priority is ensuring the short- and long-term protection of residents, school communities and workers in this neighborhood.

6. Five-Year Review Process

6.1. Administrative Components

EPA Region 9 initiated the FYR in September 2013 and scheduled its completion for September 2014. The review team was led by Max Shahbazian of the Regional Board, Project Manager for the AMD, TRW, and Offsite OUs, and Melanie Morash of the EPA, Remedial Project Manager (RPM) for the AMD, TRW, and Offsite OUs. The team also included Heather Whitney (chemist) and Dave Sullivan (geologist) with the US Army Corps of Engineers (USACE), Seattle District. In September 2013, EPA and the State of California held a scoping call with the review team to discuss the Sites and items of interest as they related to the protectiveness of the remedy currently in place. A review schedule was established that consisted of the following:

- Community notification;
- Document review;
- Data collection and review;
- Site inspection;
- Local interviews; and
- Five-Year Review Report development and review.

6.2. Community Involvement

On May 30, 2014, a public notice was published in the *Sunnyvale Sun* announcing the commencement of the Five-Year Review process, providing RWQCB and EPA's contact information, and inviting community participation. The press notice is available in Appendix B. No one contacted EPA as a result of this advertisement.

The Five-Year Review report will be made available to the public once it has been finalized. Copies of this document will be placed in the designated public repository: EPA Record Center, US EPA Region IX, 95 Hawthorne Street, San Francisco, CA, 94105.

6.3. Document Review

This FYR included a review of relevant, site-related documents including the ROD, remedial action reports, and recent monitoring data. A complete list of the documents reviewed can be found in Appendix A.

6.3.1. ARARs Review

Section 121 (d)(2)(A) of CERCLA specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs). ARARs are those standards, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action (RA), location, or other circumstance at a CERCLA site.

The ROD selected the soil cleanup standard for all OUs as background or 1.0 mg/kg total VOCs, based upon existing Regional Board policy. There are currently no ARARs established for cleanup levels in contaminated soil.

Chemical-specific ARARs identified in the selected remedies within the ROD for the groundwater at this Site and considered for this FYR for continued groundwater treatment and monitoring are listed in Table 7. For nine of the ten COCs, the cleanup level in the ROD was set at the state Maximum Contaminant Level (MCL). The cleanup standard for 1,2-DCB did not have a state MCL at the time of the ROD; therefore, the federal MCL was selected. Since the ROD was issued, the state has adopted a cleanup level for 1,2-DCB equal to the federal MCL. There have been no other changes to chemical-specific ARARs.

Table 7. Summary of Groundwater ARAR Changes

				MCLs at Time of ROD (µg/L)		Current MCL Regulations (µg/L)		ARARs Changed?
Chemical	**Applicable OU**	**1991 ROD Cleanup Standard (µg/L)**	**Basis**	**State**	**Federal**	**State**	**Federal**	
1,1-DCA	All	5	State	5	NA	5	NA	No changes.
1,2-DCB	AMD, TRW	600	Federal	NA	600	600	600	State has adopted federal MCL.
cDCE	All	6	State	6	70	6	70	No changes.
tDCE	All	10	State	10	100	10	100	No changes.
1,1-DCE	All	6	State	6	7	6	7	No changes.
Freon 113	All	1200	State	1200	NA	1200	NA	No changes.
PCE	AMD, TRW, Offsite	5	State	5	5	5	5	No changes.
TCE	All	5	State	5	5	5	5	No changes.
1,1,1-TCA	All	200	State	200	200	200	200	No changes.
Vinyl chloride	AMD, TRW, Philips	0.5	State	0.6	2	0.5	2	No changes.

Federal and state laws and regulations other than the chemical-specific ARARs that have been promulgated or changed over the past five years are described in Table 8. ARARs identified in the 1991 ROD that are no longer pertinent are not included in the table. Several original ARARs pertaining to air emissions from air strippers are no longer applicable at the AMD and TRW sites because air stripping is no longer used. Groundwater extraction and treatment at the TRW site has been suspended since 2001. At

the AMD site, treated groundwater is re-circulated and is no longer discharged to surface water or publicly owned treatment works. Groundwater extracted from the Offsite OU is piped to the treatment facility at the Philips OU for treatment and subsequent discharge to surface water. Effluent discharge ARARs are therefore no longer applicable for the AMD and TRW sites.

There have been no revisions to laws and regulations that affect the protectiveness of the remedy.

Table 8. Applicable or Relevant and Appropriate Requirements Evaluation

Requirement	Citation	Document	Description	Affected OU	Effect on Protectiveness	Comments	Amendment Date
Effluent Discharge Requirements	National Pollutant Discharge Elimination System (NPDES)	1991 ROD	Provides requirements for effluent discharges.	Offsite OU		Treated groundwater from the OOU is discharged to surface water under an NPDES permit.	

6.3.2. Human Health Risk Assessment Review

A human health risk assessment was completed for the combined sites as part of the Baseline Public Health Evaluation (BPHE) completed prior to issuance of the 1991 ROD. Although the BPHE was unavailable for review, the ROD summarizes the conclusions of the BPHE. The ROD summarized the site risks and exposure pathways from the BPHE as shown in Table 9. Exposure to soil was not evaluated because documented contamination was at depths of greater than eight to ten feet.

Table 9. Summary of Site Risks Identified in BPHE

OU	Medium	Exposure Scenario & Pathway	Risk Driver(s)	Current/ Future	Average Excess Cancer Risk Estimate	Maximum Excess Cancer Risk Estimate
AMD, TRW, Philips	Groundwater	Groundwater Ingestion	Residential Adults	Future	0.002	0.5
AMD, TRW, Philips	Groundwater	Inhalation of vapors (showering/cooking)	Residential Adult	Current	$3x10^{-4}$	0.1
AMD, TRW, Philips	Air	Inhalation of vapors (volatilized from groundwater)	Residential	Future	$4x10^{-5}$	$8x10^{-4}$
Offsite	Air	Inhalation of vapors (volatized from groundwater)	Residential	Not defined	$9.1x10^{-7}$	$5.75x10^{-5}$
TRW	Air stripper emissions	Inhalation of emissions	Not defined	Not defined	$1.79x10^{-5}$	NA

The assessments were reviewed to identify any changes in exposure pathways or toxicity that would impact protectiveness. Where appropriate, comparisons are made to EPA Regional Screening Levels (RSLs). RSLs are risk-based concentrations derived from standardized equations combining exposure information assumption with EPA toxicity data; the values are used for site screening to help identify

areas, contaminants, or conditions that may require further attention. RSLs are available for a variety of media including soil and groundwater.

Soil. Prior to the completion of soil remediation activities, soil exposure pathways were only possible in the AMD and TRW OUs; no soil source exists in the Offsite OU. However, the 1991 ROD did not identify any soil exposure pathways for these two OUs based on the following: the assumption that no shallow (less than 2 feet) contaminated soil remains on the sites, and that any residual soil contamination would occur at depths of greater than 10 feet and thus is unlikely to present a direct contact or ingestion scenario at that depth.

Groundwater. The groundwater exposure pathways identified in the ROD are still valid assumptions. Groundwater data from 2012 indicates that multiple VOCs, including PCE, TCE, cDCE, tDCE, and vinyl chloride are still detected in the shallow aquifers at the combined sites at concentrations greater than their respective groundwater cleanup levels. Groundwater from the shallow zone below the combined sites is not currently used for drinking purposes, and institutional controls prohibit and/or regulate installation of wells and use of site groundwater. The groundwater exposure pathway is therefore incomplete. Vapor intrusion risk from contaminated groundwater is evaluated in the following section.

Vapor Intrusion. EPA's understanding of contaminant migration from soil gas and/or groundwater into buildings has evolved over the past few years leading to the conclusion that vapor intrusion may have a greater potential for posing risk to human health than assumed when the ROD was prepared. The potential for vapor intrusion is evaluated following a "multiple lines of evidence" approach consistent with EPA's April 2013 "External Review Draft – Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air." Subsequently, in December 2013, EPA Region 9 released further guidelines for vapor intrusion evaluations relevant to the South Bay NPL Sites, which includes AMD 901/902, TRW, and the Offsite OUs.

EPA's 2011 TCE Toxicological Review assessment concluded that TCE exposure poses potential human health hazards for non-cancer toxicity to multiple organs and to the developing fetus, including fetal cardiac malformations. This and other findings of the TCE assessment indicate that women in the first trimester of pregnancy are one of the most sensitive populations to TCE inhalation exposure and that the TCE impacts during fetal development are by definition near-term impacts. In a June 30, 2014 Memorandum, EPA Region 9's toxicologists recommended interim action levels and response actions to address potential developmental hazards arising from inhalation exposures to TCE in indoor air from subsurface vapor intrusion. On July 14, 2014, the EPA Region 9 Director of Superfund distributed the toxicologists' findings to all Superfund staff, recommending that the action levels and response actions be considered at all Region 9 Sites. On August 27, 2014, EPA's Office of Superfund Remediation and Technology Innovation (OSTRI), issued a memorandum suggestion that the regions should consider early or interim actions where appropriate to eliminate, reduce or control hazards.

COCs in the groundwater at the three OUs include chlorinated VOCs such as TCE, PCE, cDCE, and vinyl chloride, all of which are sufficiently toxic and volatile to be considered for vapor intrusion potential. The current indoor air risk is evaluated by OU in Section 6.4. For each OU for which indoor air data is available, comparisons are made to the EPA indoor air regional screening levels (RSLs) and,

where available, the May 2013 indoor air screening levels as modified by the Department of Toxic Substances Control (DTSC; State of California) (DTSC, 2013). Where indoor air data is unavailable or insufficient, groundwater data is compared to target groundwater concentrations protective of indoor air as calculated using EPA's Vapor Intrusion Screening Level (VISL) calculator.

Toxicity values: EPA's Integrated Risk Information System (IRIS) has an online interface that can be used to determine whether toxicity values used by the Agency in a risk assessment have since been updated because newer scientific information has become available. In the past five years, there have been a number of changes to the toxicity values for certain contaminants of concern at the site. Revisions to the toxicity values have occurred since the ROD for all ten contaminants of concern (COCs) as indicated in Table 10.

Table 10. Revisions to toxicity values since the ROD

COC	Toxicity Values				Change
	Cancer		Noncancer		
	IUR	SFo $(mg/kg\text{-}d)^{-1}$	RfCi	RfDo (mg/kg-d)	
1,2-DCB	OLD: NA NEW: NA	OLD: NA NEW: NA	OLD: NA NEW: 0.2 mg/m^3	OLD: 0.01 NEW: 0.09	C: No change NC: New RfCi; Less stringent RfDo
1,1-DCA	OLD: NA NEW: $1.6x10^{-6}$ $(ug/m^3)^{-1}$	OLD: 0.091 NEW: 0.0057	OLD: 0.1 NEW: NA	OLD: 0.1 NEW: 0.2	C: New IUR. Less stringent SFo NC: Less stringent
1,1-DCE	OLD: 1.2 $(mg/kg\text{-}day)^{-1}$ NEW: NA	OLD: 0.6 NEW: NA	OLD: NA NEW: 0.2 mg/m^3	OLD: 0.009 NEW: 0.05	C: Less stringent NC: New RfCi; Less stringent RfDo
cDCE	OLD: NA NEW: NA	OLD: NA NEW: NA	OLD: NA NEW: NA	OLD: 0.02 NEW: 0.002	C: No change NC: More stringent
tDCE	OLD: NA NEW: NA	OLD: NA NEW: NA	OLD: NA NEW: NA	OLD: 0.02 NEW: 0.02	C: No change NC: No change
FREON 113	OLD: NA NEW: NA	OLD: NA NEW: NA	OLD: NA NEW: 30 mg/m^3	OLD: 3 NEW: 30	C: No change NC: less stringent RfDo; new RfCi
TCE	OLD: 0.017/(mg/kg-day) [$4.86x10^{-6}$ $\mu g/m^3$] NEW: $4.1x10^{-6}/\mu g/m^3$	OLD: 0.011 NEW: 0.046	OLD: NA NEW: 0.002 mg/m^3	OLD: NA NEW: 0.0005	C: More stringent SFo. Less stringent IUR NC: New
PCE	OLD: 0.0033/(mg/kg-day) [$9.43x10^{-7}$ $\mu g/m^3$] NEW: $2.6x10^{-7}/(\mu g/m^3)$	OLD: 0.051 NEW: 0.0021	OLD: NA NEW: 0.04 mg/m^3	OLD: 0.01 NEW: 0.006	C: Less stringent NC: New RfCi; more stringent RfDo
1,1,1-TCA	OLD: NA NEW:NA	OLD: NA NEW: NA	OLD: 0.03 mg/kg-day [0.105 mg/m^3] NEW: 5.0 mg/m^3	OLD: 0.09 NEW: 2.0	C: No change NC: Less stringent
Vinyl chloride	OLD: 0.295/(mg/kg-day) [$8.43x10^{-5}$ $(\mu g/m^3)^{-1}$] NEW: $4.4x10^{-6}$ $/(\mu g/m^3)$	OLD: 2.3 NEW: 0.72	OLD: NA NEW: 0.101	OLD: NA NEW: 0.00303	C: Less stringent NC: New

C – Cancer; IUR – Inhalation Unit Risk; NC – Non-cancer; RfCi – Inhalation Reference Concentration; RfDo – (oral) Reference Dose; SFo – Oral Slope Factor; NA – not available.

EPA no longer recommends using inhalation toxicity values that are derived from oral data (i.e., no longer using inhalation slope factor [SFi] or inhalation reference doses [RfDi]). For comparison with newer IURs, in units of $(\mu g/m^3)^{-1}$, older inhalation toxicity values are converted to IURs for cancer risks using the following formula: IUR $(\mu g/m^3)^{-1}$ = [SFi $(mg/kg\text{-}day)^{-1}$ x (20 m^3/day) x (0.001 mg/ug)]/70 kg. Non cancer inhalation reference doses are converted to noncancer hazards. Converted IUR and RfCi values are shown in brackets "[ ]" following the original inhalation toxicity value.

In general since the ROD, new noncancer toxicity values are now available for many of the COCs and several toxicity values have been revised. Cancer toxicity revisions have generally been toward less stringent values, except for TCE (discussed in more detail below). Table 11 illustrates the impact of toxicity value revisions via a comparison of ROD cleanup standards to the May 2014 EPA tapwater multi-pathway RSLs.

Table 11. Comparison of ROD Cleanup Levels to November 2013 EPA RSLs.

COC	ROD Cleanup Level (µg/L)	Tapwater multipathway Cancer RSL (µg/L)	Tapwater multipathway noncancer RSL (µg/L)	State MCL (µg/L)	Federal MCL (µg/L)	ROD Cleanup Level protective?
1,1-DCA	5	**2.4**	2900	5	NA	Yes
1,2-DCB	600	--	**280**	600	600	Yes
1,1-DCE	6	--	260	6	7	Yes
cDCE	6	--	36	6	70	Yes
tDCE	10	--	360	10	100	Yes
Freon 113	1200	--	53000	1200	NA	Yes
PCE	5	9.7	35	5	5	Yes
TCE	5	**0.44**	**2.6**	5	5	Yes
1,1,1-TCA	200	--	7500	200	200	Yes
Vinyl chloride	0.5	**0.015**	36	0.5	2	Yes

Notes. Bold indicates RSL value is below the respective ROD cleanup level. Noncancer RSLs are based on a target hazard quotient of 1.

The ROD cleanup levels are above tapwater multi-pathway RSLs for four COCs: 1,1-DCA; 1,2-DCB; TCE, and vinyl chloride, indicating that the cleanup level may not be protective.

For cancer risk, EPA uses a lifetime excess cancer risk range between 10^{-4} and 10^{-6} for assessing potential exposures. Three COCs (1,1-DCA, TCE, and vinyl chloride) have ROD cleanup levels above cancer RSLs; however, the respective cleanup levels are within EPA's protective excess cancer risk range of 10^{-4} to 10^{-6}. The ROD cleanup levels for 1,1-DCA, TCE, and vinyl chloride are therefore still considered protective of cancer risks. For noncancer risk, two COCs (1,2-DCB and TCE) have ROD cleanup levels above the noncancer RSL. Any concentration below the non-cancer RSL indicates that no adverse health effect from exposure is expected. Concentrations significantly above the non-cancer RSL may indicate an increased potential of noncancer effects. Each of these two COCs is discussed in more detail below.

1,2-DCB. The noncancer RSL for 1,2-DCB is less than the ROD cleanup level; however, the cleanup levels are equal to current state or federal MCLs (whichever is less). EPA considers the MCLs to be protective of human health. Therefore, the ROD cleanup level is still considered protective of noncancer risks.

TCE. Toxicity values for TCE were most recently revised on IRIS in September 2011 following EPA review. EPA's 2011 Toxicological Review for TCE also developed safe levels that include at least a 10-fold margin of safety for health effects other than cancer. The noncancer RSL for TCE is 2.6 µg/L. EPA

considers the TCE MCL of 5 µg/L protective for noncancer effects. Therefore, the ROD cleanup level is still considered protective of noncancer risks.

Based on the above evaluation, cleanup levels remain protective and toxicity value revisions do not impact the protectiveness of the remedy.

6.3.3. Ecological Review

An ecological risk assessment was not conducted for the sites at the time of the ROD. According to the ROD, the sites did not constitute critical habitat for endangered species nor did they include or impact any wetlands. The ROD identified endangered species that use or are occasionally seen using the South San Francisco Bay. The statement above is still valid for the site.

Currently, the site is flat and includes a mix of light commercial and residential properties, with some grassy, recreational fields (adjacent to school buildings) and residential yards with landscaped vegetation, and otherwise paved roadways and asphalt parking. Very little area of the site is unpaved or contains exposed ground. Wildlife usage would be those species typically found in an urban environment (primarily birds since most of the site is covered by buildings or asphalt). Because the contamination is primarily in groundwater, terrestrial and avian receptors, if present, would not be exposed to site contamination.

6.4. Data Review

Soil, groundwater, and/or indoor air media are evaluated for each OU in the following sections.

6.4.1. AMD 901/902 Soil

Soil was an original medium of concern for the AMD 901/902 site. Site soil contamination originated from the leaking acid neutralization system. The soil component of the AMD 901/902 remedy, as stated in the ROD, was to excavate the remaining 37 cubic yards of contaminated soil and dispose of off-site.

Following the soil excavations in 1983, 1984, and 1992, maximum residual total VOC concentrations in the unsaturated shallow soil (less than 10 feet bgs) were below the soil cleanup standard of 1.0 mg/kg. . The Regional Board therefore considered the unsaturated zone (less than 10 feet bgs) soil investigation and remediation to be complete, as confirmed in the Regional Board's NFA letter (RWQCB, 2008).

Soil samples within the saturated soil (greater than 10 feet bgs) were collected at depths up to 21 feet bgs during the 1992 excavation. The highest total VOC concentrations were reported for the soil sample collected at the final depth of the excavation (21 ft) where total VOC concentrations were 13.2 mg/kg; cDCE, a biodegradation product of TCE, was the major VOC reported (11 mg/kg). In their 2008 NFA letter, the Regional Board considered these soil samples to be representative of VOC-affected groundwater, which was addressed previously by the GWETS and currently by the ongoing ISB program. Subsequent saturated zone soil confirmation samples have not been collected to confirm achievement of the soil cleanup level, as groundwater cleanup continues.

6.4.2. AMD 901/902 Groundwater

Groundwater is the primary medium of concern at the AMD 901/902 site. Groundwater monitoring data associated with the site, with an emphasis on data collected since October 2009, were reviewed and evaluated.

The groundwater monitoring program currently consists of two parts: 1) annual site-wide groundwater monitoring samples to document and evaluate the concentrations and extent of Site-related groundwater impacts and 2) quarterly groundwater samples to assess the effectiveness of the ISB and modifications to the ISB. A network of 21 wells is sampled as part of the annual monitoring program. Of these, four wells are included in the suite of nine wells sampled quarterly to assess the ISB progress. Seven former extraction wells, approximately 10 ISB-related wells, and several non-AMD monitoring wells also exist on the site. Quarterly monitoring reports are produced following ISB sampling events in the first three quarters of each year. Following annual sampling typically held in October and fourth quarter ISB sampling around the same time, an evaluation of the data is presented in a combined annual and ISB monitoring report.

Groundwater Flow

The general direction of groundwater flow remains to the north-northeast in the aquifer A, B1, B2, B3, and B4 zones except where influenced by groundwater extraction wells on neighboring sites (A, B1, and B2 zones shown in Figure 8, Figure 9, and Figure 10). The vertical hydraulic gradient remains upward in the shallow aquifers at the AMD OU.

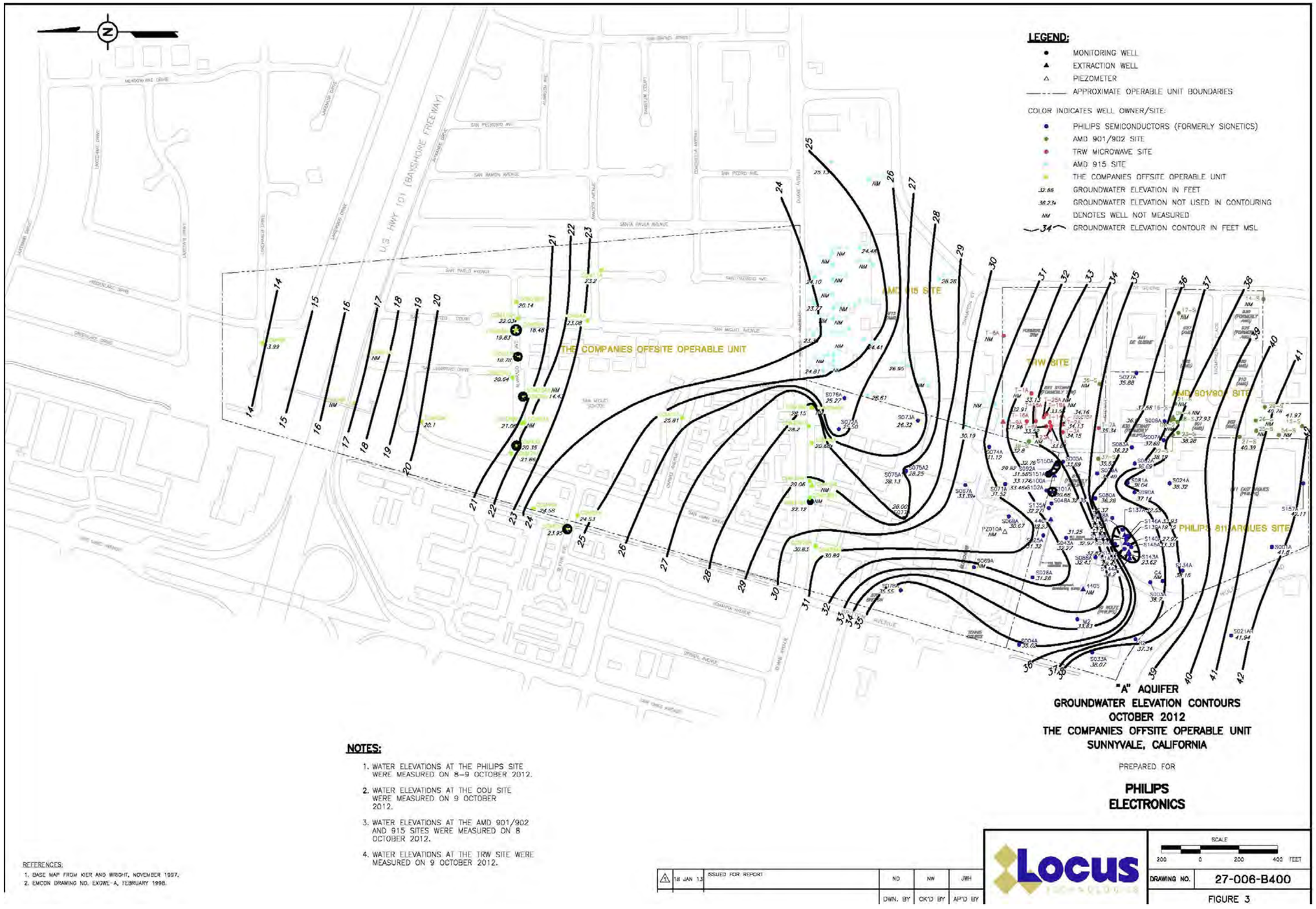

Figure 8. Groundwater elevation contours in aquifer A zone, October 2012

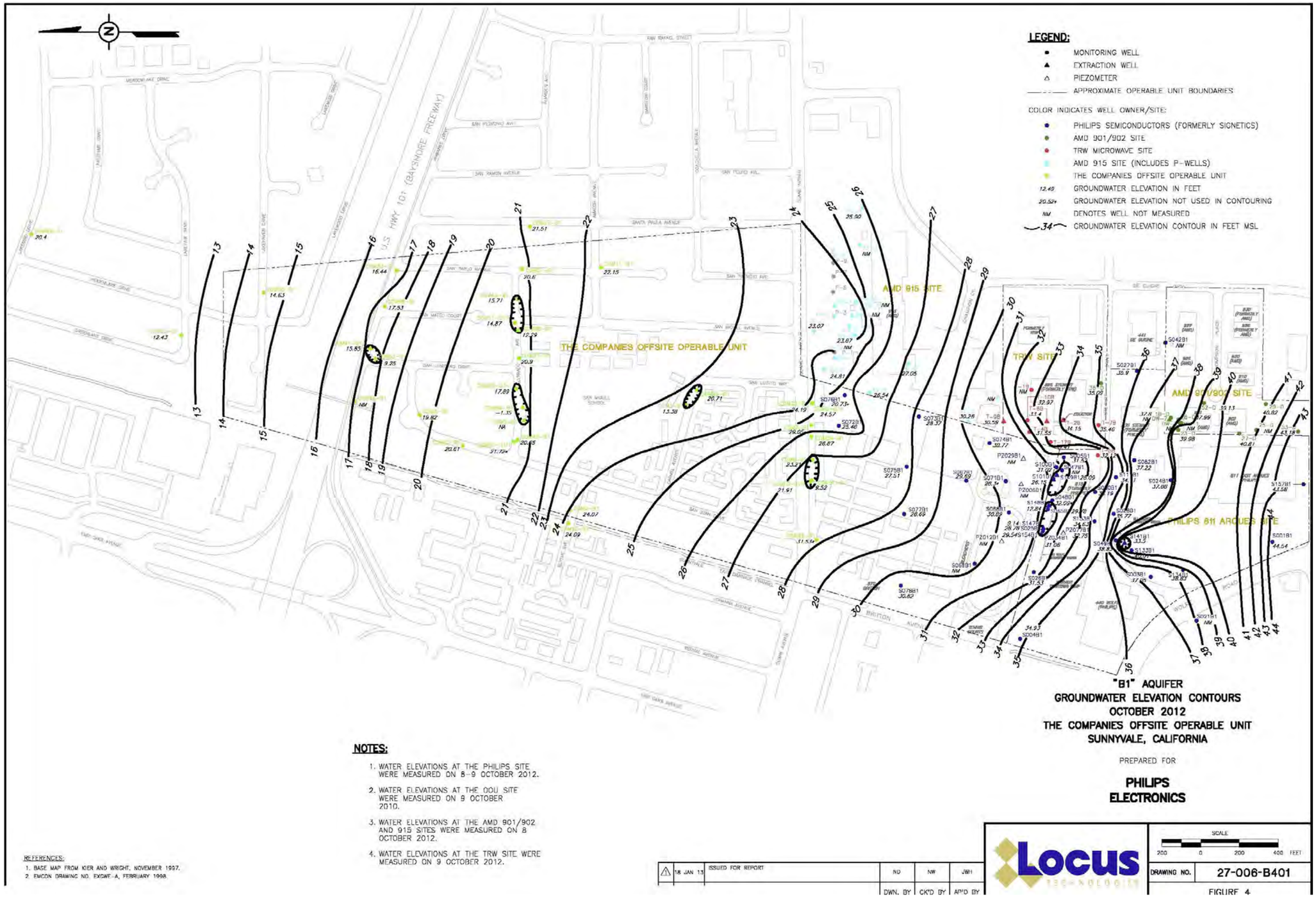

Figure 9. Groundwater elevation contours in aquifer B1 zone, October 2012

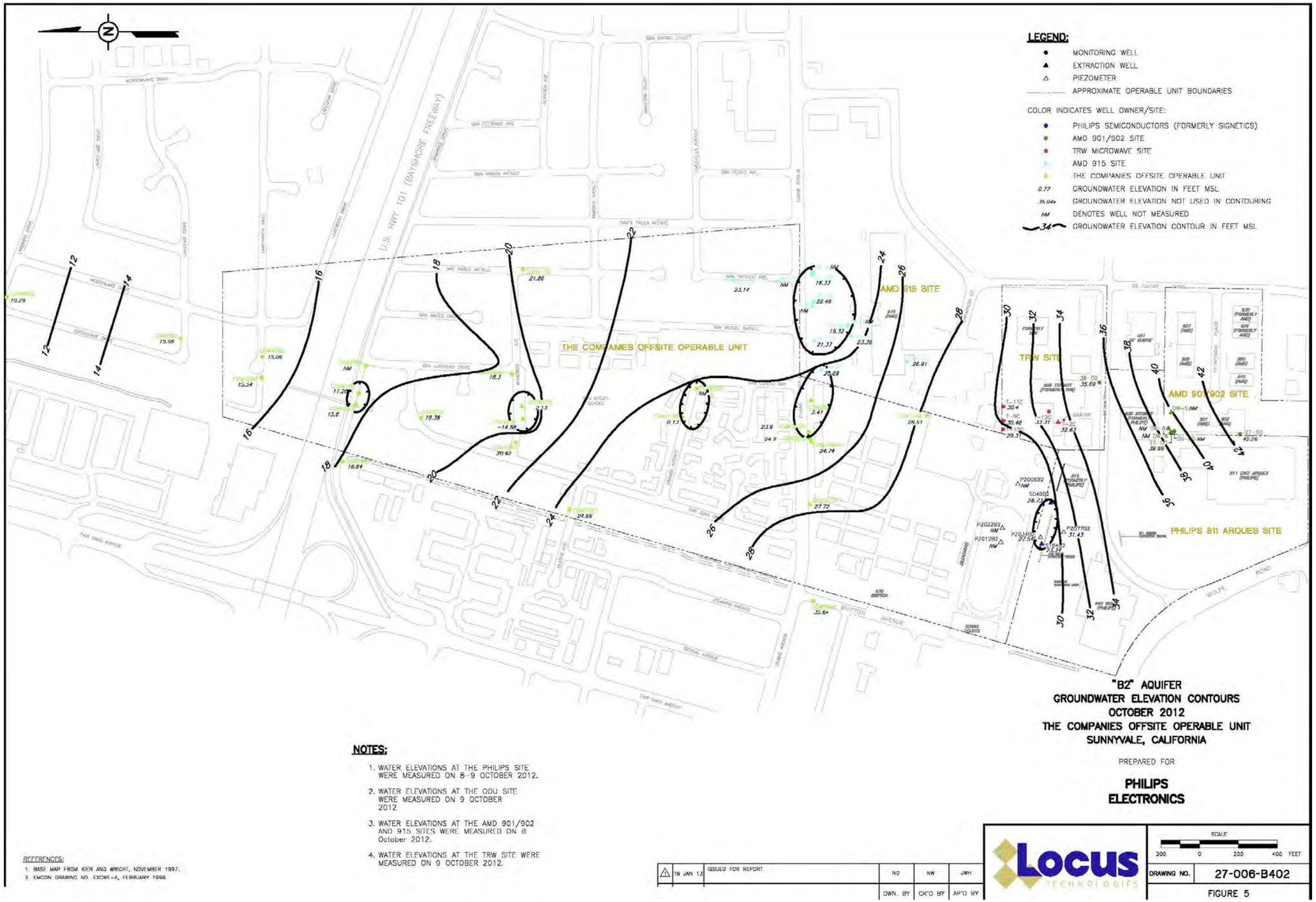

Figure 10. Groundwater elevation contours in aquifer B2 zone, October 2012

Groundwater Chemistry

Impacted groundwater associated with past site-related activities is primarily restricted to the north portion of the AMD OU. All COCs have been detected historically at this OU; in 2013, only five COCs (PCE, TCE, cDCE, tDCE, and vinyl chloride) remained at levels above their respective cleanup standards in one or more of the shallow aquifers. Of these, TCE, cDCE, and vinyl chloride are present in the highest concentrations.

Table 12 presents the maximum concentrations for each zone in the area up-gradient of the former source area, at the fomer source area, and down-gradient of the former source area. COCs at the AMD OU are limited to the aquifer A, B1, and B2 zones. The majority of the contamination is restricted to the A and B1 zones, except for TCE in the B2 zone of the up-gradient and source areas and cDCE and vinyl chloride in the B2 zone of the down-gradient area. No COCs were detected in the B3 zone.

Table 12. AMD 901/902 Maximum 2013 Annual Groundwater Concentration by Aquifer Zone and Location Relevant to Source Area

		Up-gradient			Former source area				Down-gradient		
COC	**Cleanup Level (µg/L)**	**A**	**B1**	**B2**	**A**	**B1**	**B2**	**B3**	**A**	**B1**	**B2**
1,1-DCA	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-DCB	600	ND	ND	ND	28	4	ND	ND	ND	ND	ND
1,1-DCE	6	ND	ND	ND	1.5	ND	ND	ND	ND	ND	ND
cDCE	6	**110**	1.3	5.8	**130**	**22**	3.8	ND	**8.1**	**28**	**11**
tDCE	10	4.5	ND	ND	**13**	4.4	ND	ND	ND	0.8	0.9
Freon 113	1200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCE	5	**14**	4.3	1.4	1.1	ND	ND	ND	2.3	1.3	ND
1,1,1-TCA	200	0.8	0.8	ND	ND	0.7	ND	ND	0.5	ND	ND
TCE	5	**230**	**88**	**37**	**37**	**280**	**170**	ND	**95**	**38**	ND
Vinyl Chloride	0.5	**2.7**	ND	ND	**34**	**160**	ND	ND	ND	ND	**1.3**

Notes. All concentrations are in µg/L**. Bold** values indicate maximum concentrations that exceed the cleanup level. Only wells sampled annually were evaluated.

Across all aquifer zones, the highest concentrations of cDCE, tDCE, TCE, and vinyl chloride occur within the source area, which indicates that the former source area is still contributing to groundwater contamination. The notable exception is PCE, for which the maximum concentration occurs in the up-gradient A zone; however, down-gradient PCE concentrations are below cleanup levels likely due to successful treatment by the AMD OU remedy. PCE is not associated with former AMD operations and its detection along with TCE and cDCE in wells up-gradient or cross-gradient of former AMD source areas is an indication that groundwater at the OU is affected by up-gradient, off-site, non-AMD sources.

In general, down-gradient COC concentrations are lower than the up-gradient and former source area groundwater concentrations, indicating that the on-site treatment system is effectively reducing groundwater COCs. Only cDCE and TCE still remain in down-gradient groundwater at concentrations that exceed their cleanup levels. A subset of COCs, particularly cDCE, PCE, and TCE continue to appear

in the up-gradient wells at concentrations significantly exceeding the cleanup levels. Achievement of cleanup goals will remain a challenge as long as the migration of these COCs from up-gradient sources persists.

Overall, groundwater TCE data from source area well cluster 28-S/D for the time period 1982-2013 clearly shows that remedial efforts have greatly reduced COC concentrations in the AMD source area since implementation of the remedy began (Figure 11). However, COC concentrations remain elevated above cleanup levels at the site. Groundwater trends in the ISB treatment zone and the areas up- and down-gradient from the ISB are each discussed in more detail below. October 2013 iso-concentration contours and individual well concentration data for TCE, one of the primary COCs at the site, are presented in Figure 12, Figure 13, and Figure 14 for the first three water-bearing zones (A, B1, and B2). Groundwater concentration plots of TCE versus time for each area are presented in Figures 15 through 19. Additional information supporting the data review is provided in Appendix F.

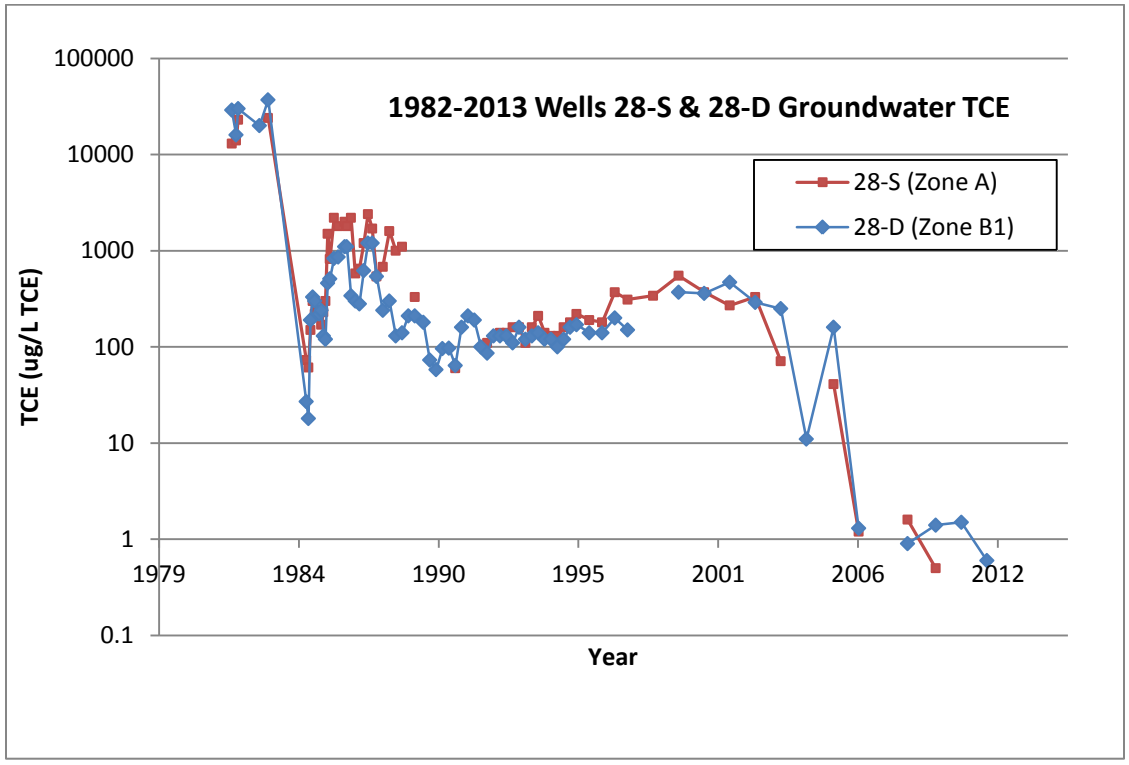

Figure 11. AMD TCE concentrations in wells 28-S and 28-D, 1982 – 2013

Figure 12. TCE iso-concentration contours and individual well concentrations in aquifer A zone, October 2013

Figure 13. TCE iso-concentration contours and individual well concentrations in aquifer B1 zone, October 2013

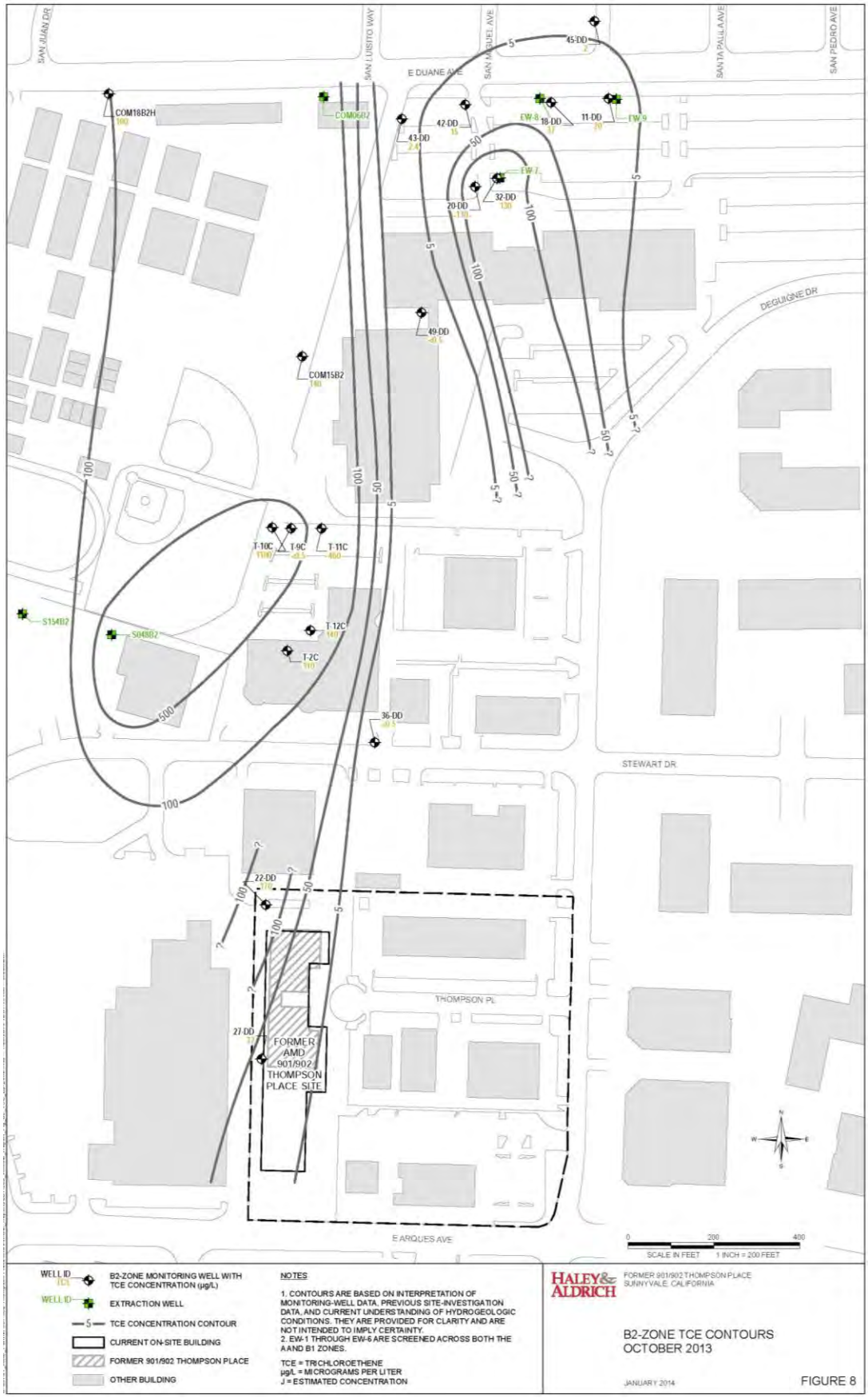

Figure 14. TCE iso-concentration contours and individual well concentrations in aquifer B2 zone, October 2013

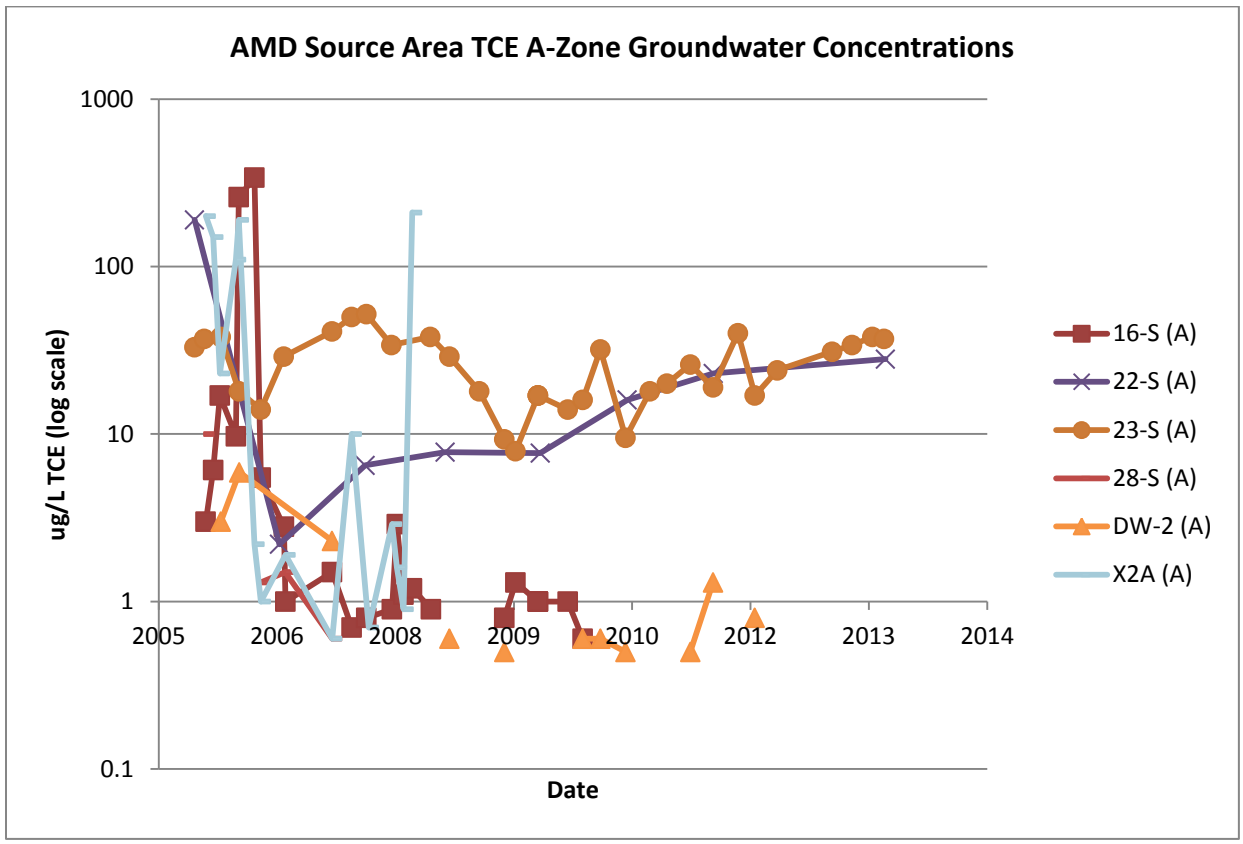

Figure 15. AMD Source Area TCE A Zone Groundwater Concentrations

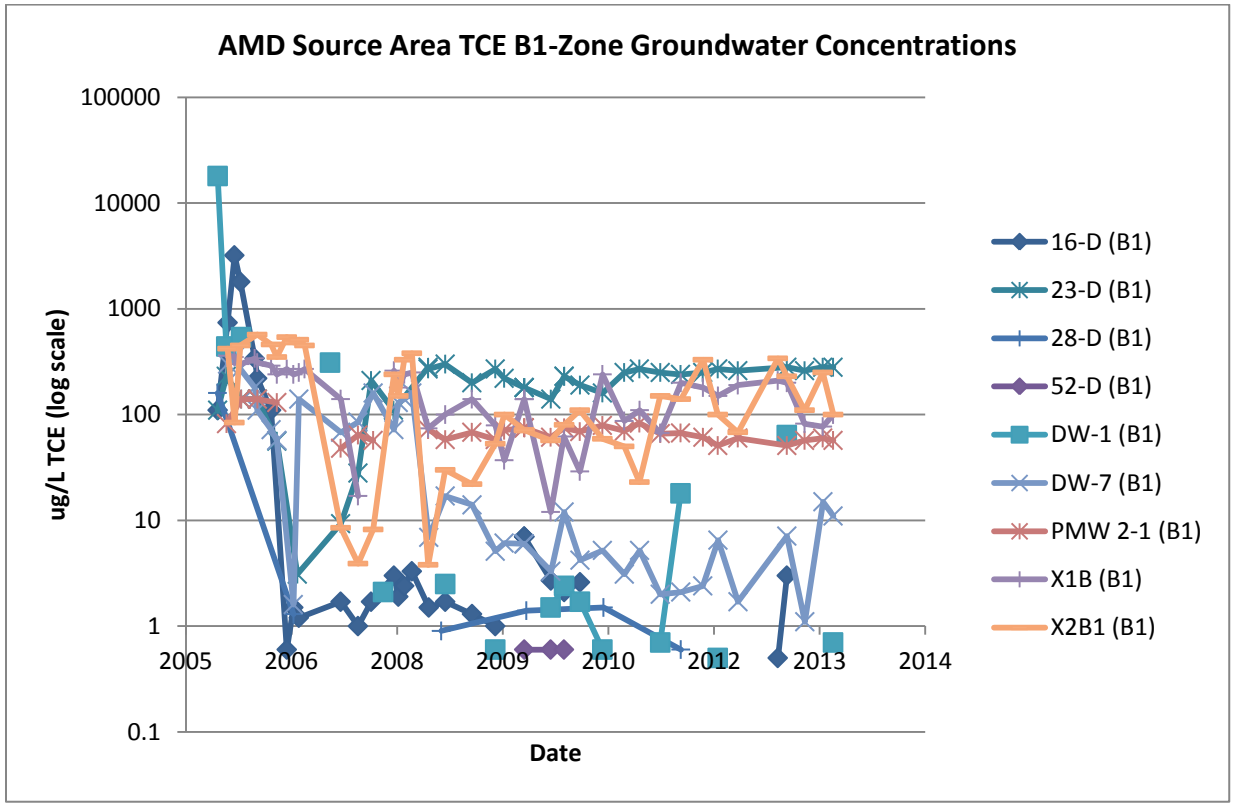

Figure 16. AMD Source Area TCE B1 Zone Groundwater Concentrations

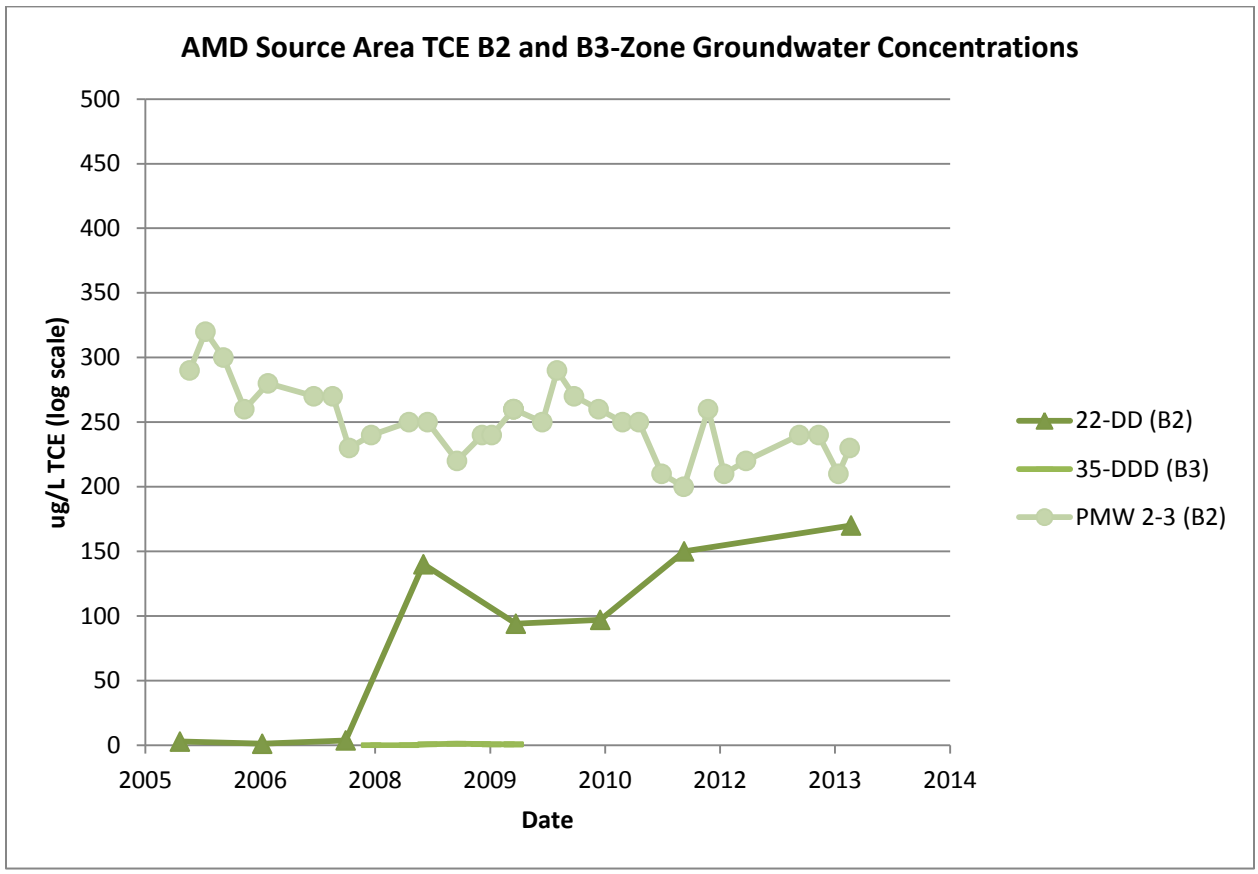

Figure 17. AMD Source Area TCE B2 and B3 Zone Groundwater Concentrations

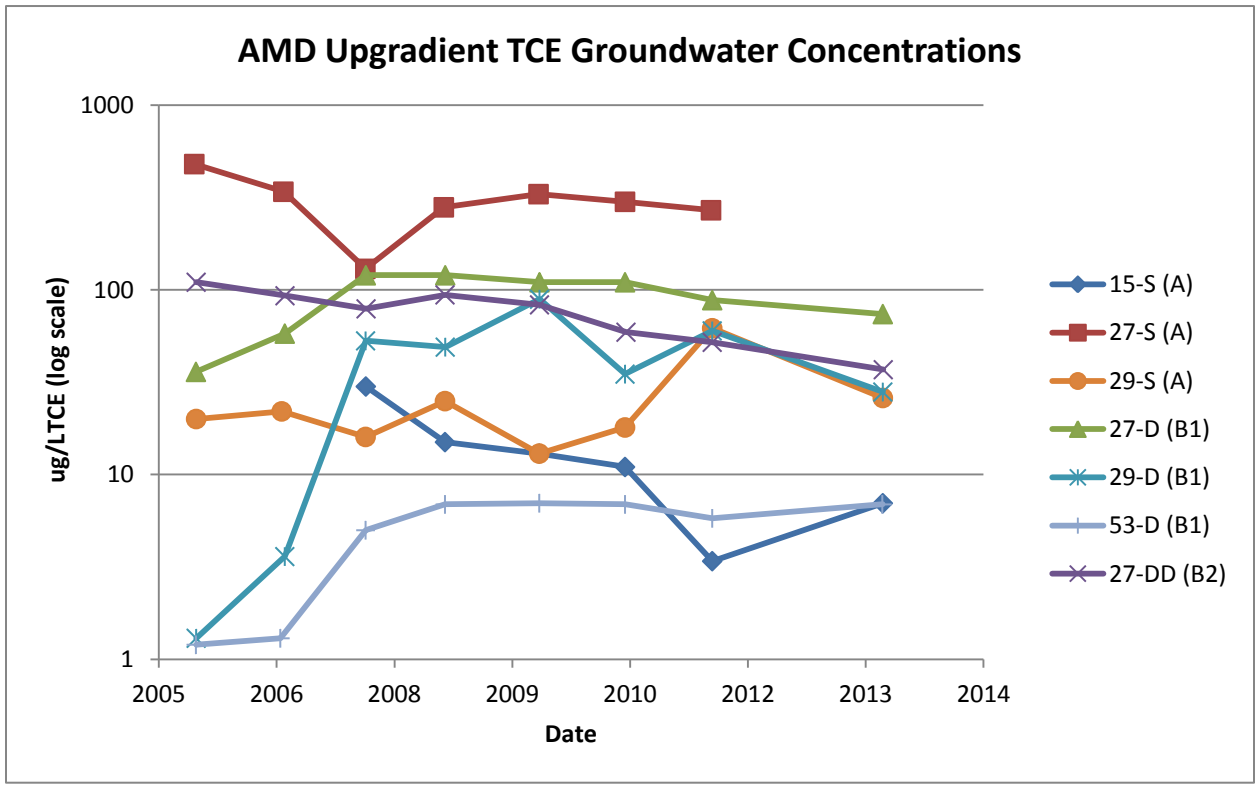

Figure 18. AMD Up-gradient TCE Groundwater Concentrations

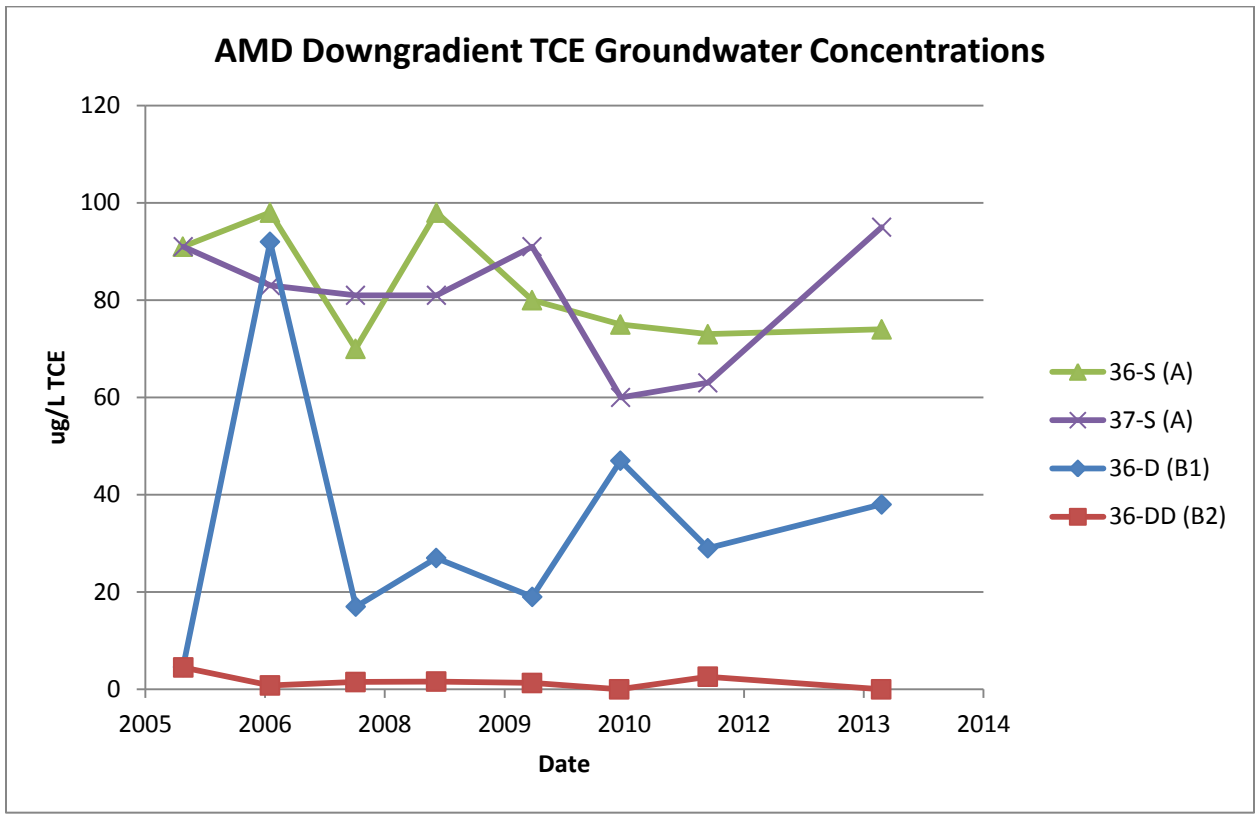

Figure 19. AMD Down-gradient TCE Groundwater Concentrations

Former Source Area

Concentrations of TCE in the core ISB treatment area are now less than the cleanup level of 5 µg/L in the aquifer A and B1 zones (Figure 12 and Figure 13). Outside the core ISB treatment area, concentrations of cDCE, tDCE, and vinyl chloride are above cleanup standards in at least one well in the A, B1, and B2 zones. Because in-situ bioremediation promotes the transformation of TCE to these intermediate breakdown products, elevated concentrations of cDCE and vinyl chloride are to be expected until biodegradation is complete. Indeed, the highest concentrations of cDCE, tDCE, and vinyl chloride were detected in the groundwater samples collected from the wells near the core of the ISB treatment zone (well clusters 16-S/D, 23-S/D, and 28-S/D).

A zone TCE concentrations dropped dramatically with the initiation of ISB in 2005; for the most part concentrations have remained relatively depressed since then, although slow rebound is being observed in wells 23-S and 22-S.

Rebound in TCE groundwater concentrations is much more apparent in the B1 zone wells, most notably B1 zone well 16-D, in which TCE concentrations rebounded to nearly 300 ug/L following temporary cessation of active ISB in May 2008 (Figure 16). TCE concentrations in the majority of the B1 zone wells were significantly reduced during the 2005-2008 period of active ISB and have remained depressed since then. Concentrations in wells 23-D and ISB extraction wells X1B and X2B1 have fluctuated since 2008, presumably in response to the intermittent ISB injections that have occurred since then, but elevated concentrations (greater than 100 ug/L) persist.

TCE concentrations in one B2 zone well (22-DD) located in the core ISB treatment area have rebounded since active ISB ceased in 2008, and current TCE concentrations remain significantly above the cleanup level for all B2 zone wells (Figure 17). TCE was not detected in the B3 zone.

Due to observed rebound in TCE concentrations and continued presence of intermediate biodegradation products (e.g., cDCE and VC) in the source area and generally stable concentrations in the down-gradient area, the existing treatment remedy may benefit from optimization to produce continued significant COC concentration decreases in the source area.

Area Up-gradient of the ISB Treatment Area

Since the last FYR, TCE concentrations remain above the cleanup level of 5 µg/L (Table 12 and Figure 18). cDCE concentrations, while generally lower than TCE concentrations, are below or near the cleanup goal in the B1 and B2 zones, but are well above the cleanup level in the A zone.

As mentioned previously, PCE is detected in the up-gradient wells at concentrations greater than those found in source and down-gradient areas. PCE is not associated with former AMD operations and its detection along with TCE and cDCE in wells up-gradient or cross-gradient of former AMD source areas is an indication that groundwater at the OU is affected by up-gradient, off-site, non-AMD sources.

Overall, up-gradient concentrations of TCE appear to be remaining fairly stable to slightly decreasing, but because up-gradient concentrations are much higher than the cleanup level, migration of off-site COC contamination into the AMD OU continues to be an issue. Specific up-gradient COC sources have not been identified.

Area Down-Gradient of the ISB Treatment Area

Down-gradient concentrations of cDCE, TCE, and vinyl chloride remain above cleanup levels, with the highest concentrations in the A and B1 zones (Table 12 and Figure 19). A and B1 zone wells have shown some fluctuations, but TCE concentrations generally appear stable since the last FYR despite the continued intermittent ISB treatment in the source area. Up-gradient sources may also be impacting the down-gradient concentrations.

6.4.3. AMD 901/902 Indoor Air

Indoor air is not an original medium of concern for the AMD 901/902 site. Since the 1991 ROD, EPA's understanding of vapor intrusion potential has increased; the 2004 FYR identified the vapor intrusion pathway as an exposure route of concern and recommended further risk analysis. In 2007, AMD assessed the vapor intrusion pathway from the groundwater plume into overlying buildings at the Site via a screening level assessment of existing shallow groundwater concentrations. The 2009 FYR recommended an indoor air investigation, which the Regional Board subsequently required. In March 2013, AMD conducted a vapor intrusion investigation at the AMD Site (AMEC, 2013c). Following the December 2013 release of additional EPA Region 9 guidelines and supplemental information, AMD performed a subsequent re-evaluation of the March 2013 indoor air data (HAI, 2014).

The existing self-storage facility was constructed within the footprint of the former AMD 901/902 building footprint. This facility is slab-on-grade with 15 inches of concrete and has 15 heating,

ventilation, and air conditioning (HVAC) units in service. In March 2013, an indoor air evaluation was conducted within the self-storage facility. Both indoor and ambient air samples were collected as part of this evaluation. Indoor air samples were collected from hallways, bathrooms, pathway locations and other interior public areas and not within individual storage units. The indoor air evaluation analyzed for 14 VOCs that were detected in groundwater samples from the A and B1 groundwater zones during the most recent two years of annual sampling events.

As part of this indoor air evaluation, preferential pathways were identified prior to indoor air sampling using a Photo Ionization Detector (PID) with a reporting limit of 1 part per billion (ppb) by volume isobutylene. These included joints throughout the building concrete slab, floor drains, and various pipes and utility lines that pass through the concrete slab, elevators, and a fire sprinkler riser that enters the building at a height of approximately 15 feet at the eastern central portion of the building.

Sample locations included nine indoor air samples and two ambient air samples. The HVAC system was turned off for 36 hours prior to sampling and remained off until the sampling effort was complete. Sampling was not conducted with the HVAC system on. Selected samples were positioned near potential preferential pathways.

In all of the indoor air samples collected 1,4-DCB was present at concentrations above the EPA RSL of 1.1 microgram per cubic meter (µg/m^3) for commercial/industrial air. This compound was not detected in the ambient air samples but was detected at low levels in groundwater (maximum concentration from October 2012 was 2.4 micrograms per liter [µg/L] in well 16-S). This compound is not included in the COC list in the ROD.

No other chemicals were detected above either EPA's commercial/industrial air RSLs or DTSC-modified indoor air screening levels. Table 13 lists the chemicals, maximum detected concentrations, and respective applicable screening levels.

Table 13. AMD 901/902 2013 Maximum Indoor Air Concentrations

Chemical	Maximum Detected Indoor Air Concentration (µg/L)	Indoor Air EPA RSL (industrial) (µg/m^3)	DTSC –modified Indoor Air industrial screening levels[1] (µg/m^3)
1,1,1-TCA	2.3	22,000	4,400
1,1-DCA	ND	7.7	–
1,1-DCE	ND	880	310
1,2-DCB	ND	880	–
1,3-DCB	ND	–	–
1,4-DCB	**62**	1.1	–
Cis-1,2-DCE	0.14	–	31
Chloroethane	ND	44,000	–
Chlorobenzene	ND	220	–
Freon 113	0.82	130,000	–
PCE	1.8	47	2.08
TCE	1.5	3.0	–

Chemical	Maximum Detected Indoor Air Concentration (µg/L)	Indoor Air EPA RSL (industrial) (µg/m^3)	DTSC –modified Indoor Air industrial screening levels[1] (µg/m^3)
Trans-1,2-DCE	ND	260	–
Vinyl chloride	ND	2.8	0.16

Notes: ND – not detected. Values shown in **bold** exceed either the EPA RSL or DTSC-modified screening level.
1 – California DTSC, Office of human and Ecological Risk (HERO), Human Health Risk Assessment (HHRA) Note 3 (May 21, 2013).

For ROD COCs it appears that vapor intrusion is not an issue based on the following lines of evidence:

- TCE or cis-1,2-DCE were not detected at concentrations above screening levels in the indoor air samples despite groundwater concentrations of these COCs in the shallow zone an order of magnitude above ROD cleanup levels.

- The highest level of TCE detected during the HVAC-off sampling event – 1.5 µg/m^3 – exceeds the residential indoor air RSL, however, the site is in commercial use and no residential-type exposure is to be reasonably expected. Employees of the self-storage facility are on-site from 6 am to 9 pm, and tenants are only able to access their storage units during these hours. Thus a reasonable exposure scenario for occupants or visitors to the building is well below a 24-hour residential-type scenario, and the higher commercial RSL applies.

- 1,4-DCB was detected in indoor air above the EPA RSL of 1.1 µg/m^3 for industrial air. Using the VISL calculator to determine an indoor air concentration using site groundwater concentrations, the maximum 2012 groundwater concentration of 2.4 µg/L calculates to an indoor air concentration of 0.23 µg/m^3. This is much less was than has been historically detected in air, indicating that the 1,4-DCB in the groundwater is not a source (or otherwise not a significant source) of vapor intrusion. Common uses of 1,4-DCB include disinfectants (a characteristic smell associated with urinal cakes) and pesticides used to control moths, molds, and mildew, all of which may reasonably be associated with the contents of the self-storage units.

There are currently eight building on the former AMD 901/902 property. The original building overlying the source area, has been evaluated for vapor intrusion, as described above. The remaining seven building are upgradient of the former source area; however the shallow groundwater beneath these buildings contain TCE concentrations remain above 5 µg/L. Although the buildings are not within the scope of the AMD 901/902 contamination; they should be tested for vapor intrusion.

6.4.4. TRW Soil

Soil was an original medium of concern for the TRW Site. Site soil contamination originated from the underground storage tank. The limiting factor during the original 1984 source area excavation was the presence of the existing building. Therefore, it is likely that any remaining source material is under the footprint of the previous building, adjacent to the original investigation area.

Subsequent SVE conducted between 1993 and 1998 further reduced VOC concentrations in the vadose zone beneath the former Site source area. The SVET system was removed in November 1998, and the Regional Board issued a letter stating that the SVE system had achieved the soil cleanup level (1 mg/kg total VOCs) and no further action was required in the vadose zone.

Rebounding groundwater concentrations of TCE in the Eductor in 2007 and 2008 indicated that residual source material was still contributing to groundwater concentrations. In 2013, a membrane interface probe (MIP) investigation was conducted in the vicinity of the former source area excavation to locate and delineate any residual source mass/high concentration areas. Confirmation soil samples were collected from a location next to one MIP location at depths of 10, 18, 21, 28, and 35 feet (ft) below ground surface (bgs). COCs detected included 1,2-DCB, cDCE, TCE, and vinyl chloride. The highest cDCE (860 µg/kg) and TCE (2200 µg/kg) soil concentrations were observed at the 28 ft bgs sample depth, which lies just below the aquifer A zone (5-25 ft bgs). The second highest cDCE and TCE concentrations occurred at the 35 ft bgs sample depth. The study concluded that the MIP survey did not find any evidence for remaining high-concentration VOC-impacted material in the vicinity of the original excavation. Review of the soil concentration data indicates that soil concentrations remain above the soil cleanup level.

6.4.5. TRW Groundwater

Groundwater is the primary medium of concern at the TRW site. Groundwater monitoring data associated with the site, with an emphasis on data since October 2009, were reviewed and evaluated.

The groundwater monitoring program currently consists of two parts: 1) documentation and evaluation of the concentrations and extent of Site-related groundwater impacts based on results from annual site-wide groundwater monitoring and 2) assessment of the effectiveness of the EAB, modifications to the EAB, and the non-pumping conditions based on results from semi-annual groundwater sampling. A network of 42 wells, including seven former extraction wells and the Eductor, are used for sampling as part of the annual monitoring program.

Six wells are routinely sampled during the semi-annual sampling to assess the EAB progress. Seven former extraction wells, the Eductor, and several EAB-related injection wells also exist on the site. Following the semi-annual sampling, typically in April, and the annual sampling, typically held in October, an evaluation of the data is presented in a combined annual and EAB monitoring report.

Groundwater Flow

In the 1991 ROD, groundwater flow direction at the site was to the north-northeast in all aquifer zones. In 2013, the general direction of groundwater flow remains to the north in the A and B1 zones and to the northwest in the B2 zone. The change in flow direction may be due to the influence of the groundwater extraction systems located due west at the Philips OU.

The 1991 ROD also documented the vertical hydraulic gradient to be upward under non-pumping conditions. More recent groundwater data show vertical hydraulic gradients in the downward direction between the A and B1 zones and between the B1 and B2 zones, while an upward gradient exists between the B4 zone and the overlying zones.

Groundwater Chemistry

All of the COCs are currently detected in groundwater at the site; however, the major COCs are TCE, cDCE, tDCE, 1,2-DCB, and VC. In 2013, these five COCs remained above their respective cleanup standards in one or more of the shallow aquifer zones. Of these, 1,2-DCB, cDCE, TCE, and vinyl chloride are present in the highest concentrations.

Table 14 presents the maximum concentrations for each zone in the area up-gradient of the former source area, at the former source area, down-gradient of the former source area, and at the Eductor. COCs are present in the aquifer A, B1, and B2 zones. There are no wells in the B3 zone at the TRW OU. The nearest up-gradient B3 zone well is 35-DDD, located at the AMD OU (Figure 7). All COCs were non-detect in well 35-DDD in 2013. The nearest down-gradient B3 zone well is COM15B3, located at the Offsite OU (Figure 6). In 2012, TCE was detected in this well at a concentration of 460 µg/L. The lack of B3 zone groundwater concentration data in the TRW OU is a data gap. Characterization of B3 zone groundwater COC concentrations in the TRW OU is necessary to determine whether the former source area at TRW may be a source of contamination observed in the B3 zone of the adjacent Offsite OU (section 6.4.7).

Table 14. TRW Maximum 2013 Annual Groundwater Concentration by Aquifer Zone and Location

COC	Cleanup Level (µg/L)	Up-gradient			Former source area				Down-gradient		
		A	B1	B2	Eductor	A	B1	B2	A	B1	B2
1,1-DCA	5	ND	0.56	ND	ND	ND	1	ND	0.78	0.43 J	ND
1,2-DCB	600	ND	2.2	ND	**1800**	19	10	ND	0.35 J	ND	ND
cDCE	6	**81**	**73**	**11**	**160,000**	**340**	**140**	**44**	**150**	**830**	**85**
tDCE	10	1.8 J	1.8 J	0.9	ND	**86**	1.6	ND	**12**	8.8	1.5
1,1-DCE	6	ND	2.3 J	ND	ND	0.70 J	ND	ND	0.7	3.3 J	2.4 J
Freon 113	1200	ND	190	ND	ND	0.61 J	ND	ND	1.4	1.5 J	170
PCE	5	2.3	4.8 J	ND	ND	1.9	ND	ND	2	2.2 J	ND
TCE	5	**250**	**1500**	ND	**8800**	**250**	ND	**110**	**110**	**410**	**1100**
1,1,1-TCA	200	0.5	0.59	ND	ND	ND	ND	ND	0.35 J	ND	ND
Vinyl chloride	0.5	ND	0.39 J	**1.3**	**1800**	**430**	**150**	ND	**42**	**17**	**4.8**

Notes. J = estimated value. All concentrations are in µg/L**. Bold** values indicate maximum concentrations that exceed the cleanup level. Only wells sampled annually were evaluated.

Across all aquifer zones, the maximum concentrations of 1,2-DCB, cDCE, TCE, and vinyl chloride occur in the shallow Eductor in the source area, indicating that the former source area is still a source of groundwater contamination.

Overall, groundwater TCE data from the source area well cluster T-2A/B/C for the time period 1989-2013 clearly shows that remedial efforts have substantially reduced COC concentrations in the TRW source area in the A, B1, and B2 zones since implementation of the remedy (Figure 20, Figure 21, and Figure 22, respectively). Additional information supporting the data review is provided in Appendix E.

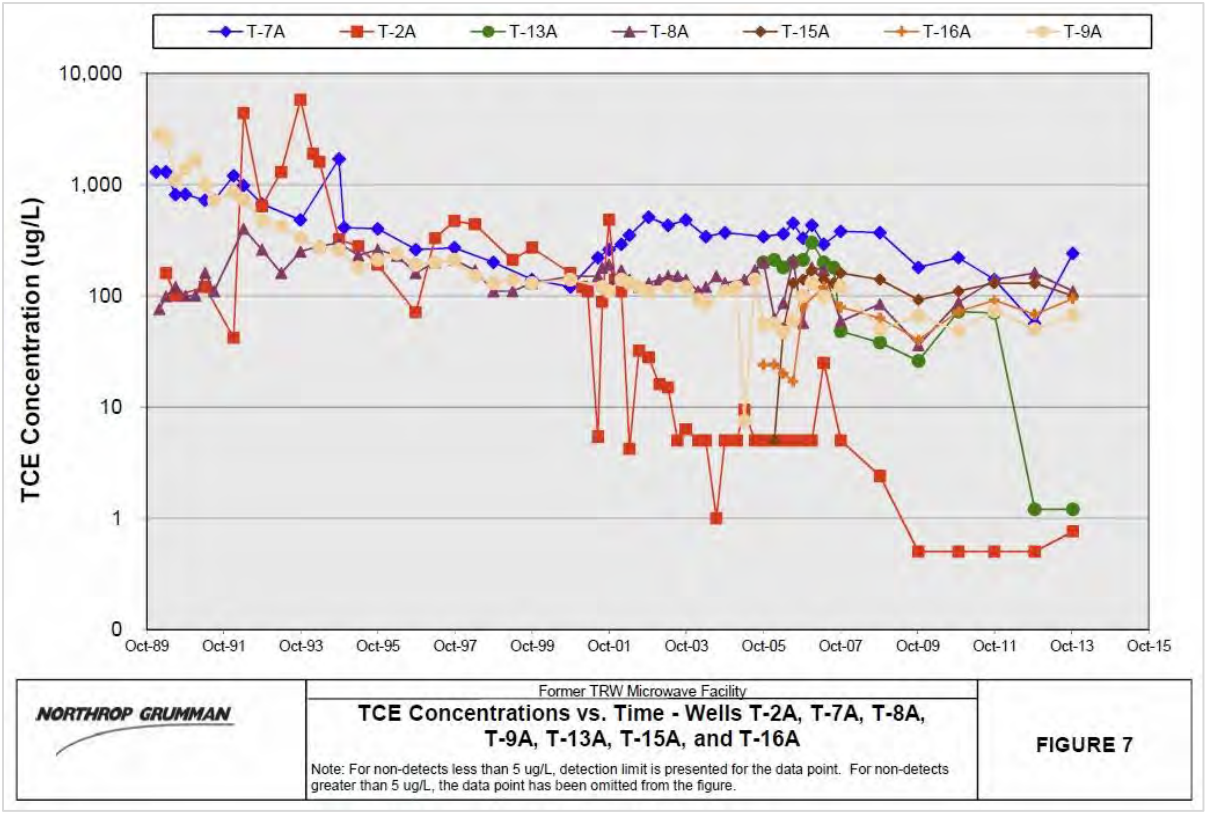

Figure 20. TRW A zone TCE concentrations 1989 – 2013

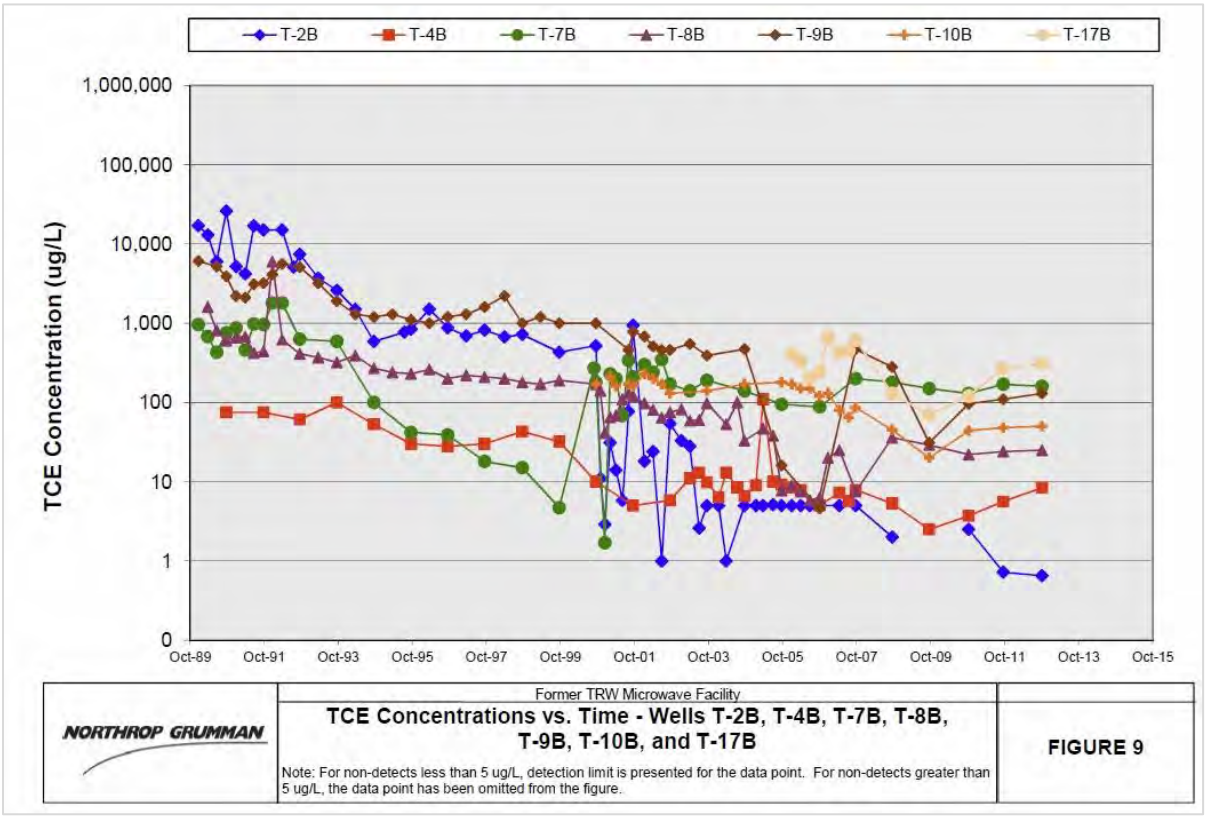

Figure 21. TRW B1 zone TCE concentrations 1989 – 2013

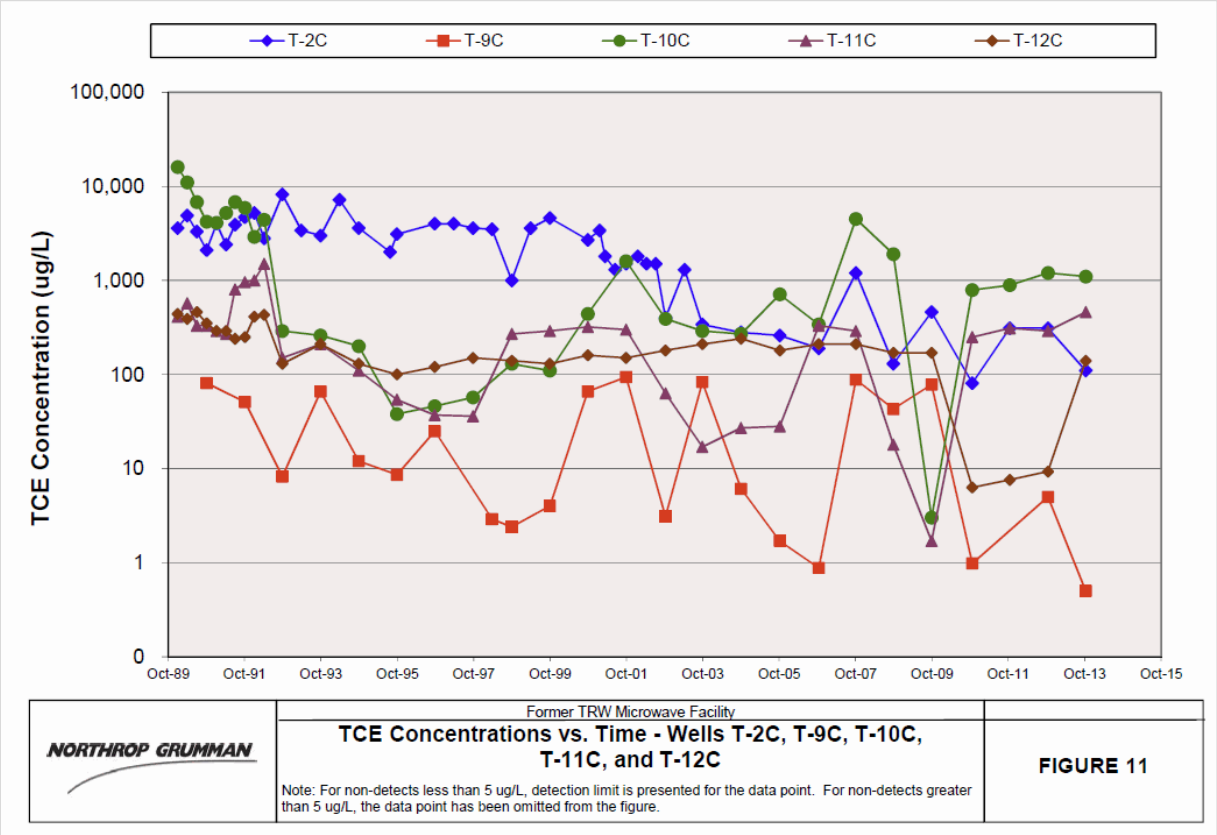

Figure 22. TRW B2 zone TCE concentrations 1989 – 2013

Former Source Area

Concentrations of 1,2-DCB, cDCE, TCE, and vinyl chloride in the shallow Eductor at the center of the former source area remain significantly above cleanup standards (Table 14). In the source area wells (T-2A/B/C cluster and T-3A), cDCE, tDCE, TCE, and vinyl chloride remain above the cleanup levels in one or more of the A, B1, and B2 zones. Because EAB promotes the transformation of TCE to the intermediate breakdown products of cDCE and vinyl chloride, elevated concentrations of cDCE and vinyl chloride are to be expected until biodegradation is complete. In general, high concentrations of cDCE and vinyl chloride are found in the source area wells, with the highest concentrations of cDCE in the Eductor, where EAB injections have occurred. In 2013, the lowest dissolved oxygen levels and sulfate concentrations occurred in the Eductor, which may be indicative of very reducing conditions. This may be stalling TCE degradation at cDCE, producing the significantly elevated cDCE concentrations observed (relative to the VC) and preventing complete TCE degradation.

Figure 20 shows that A zone TCE concentrations (well T-2A) dropped dramatically with the initiation of EAB in 2000; TCE concentrations have generally remained relatively depressed since then. cDCE concentrations in well T-2A spiked around 2009, but dropped again following the November 2010 injection of neat vegetable oil into the Eductor with a slight upward increase noted in 2013.

TCE concentrations also dropped dramatically in the B1 zone starting in 2000 and have remained consistently depressed since then. In the A zone, cDCE concentrations in well T-2B rebounded around 2009, but dropped again by 2011 following the November 2010 Eductor injection.

The TCE concentrations in the B2 zone aquifer have not shown the same dramatic decrease in response to EAB injections. Concentrations in source area well T-2C generally show steady decline with some fluctuations since 2009 (Figure 22). Due to the continued presence of high concentrations of TCE in the shallow Eductor at the center of the source area, continued treatment is needed to reduce the source. The current EAB activities may also need optimization to produce significant decreases in the deeper B2 zone TCE concentrations in the source area, which do not appear to be impacted by the Eductor injections as much as TCE concentrations in the A and B1 zones.

Area Up-gradient of the Source Area

Since the last FYR, TCE and cDCE concentrations remain above the cleanup goals (Table 14 and Figure 20, Figure 21, and Figure 22). TCE concentrations are highest in the B1 zone (wells T-5B, T-7B; Figure Figure 21) and are non-detect in the B2 zone (well 36DD; not shown on Figure 22). Since 2012, A zone TCE concentrations have dropped significantly and currently remain below the cleanup level in well T-7A directly up-gradient of the source area. TCE concentrations in up-gradient and cross-gradient A zone wells 36S and 36D remain substantially elevated (not shown on Figure 20). Maximum up-gradient concentrations of both cDCE and TCE exceed the down-gradient concentrations measured at the neighboring AMD OU (section 6.4.2), suggesting that off-site sources may be contributing to the up-gradient concentrations observed at TRW.

PCE and 1,1,1-TCA are detected in the up-gradient wells in concentrations greater than those found in the source and down-gradient areas. PCE is not associated with former TRW operations and its detection along with TCE and cDCE in wells up-gradient of the former TRW source area is an indication that groundwater at the TRW OU is impacted by up-gradient, off-site, non-TRW sources.

Overall, up-gradient concentrations of TCE appear to be remaining fairly stable to decreasing, but because up-gradient concentrations are still much higher than the cleanup level, migration of off-site COC contamination onto the TRW OU continues to be an issue. Achievement of cleanup goals will remain a challenge as long as the migration of COCs from up-gradient sources persists.

Area Down-gradient of the Source Area

Down-gradient concentrations of cDCE, tDCE, TCE, and vinyl chloride remain above cleanup levels, with the highest concentration of TCE occurring in the B1 and B2 zones (Table 14).

Maximum down-gradient concentrations are less than the source area maximum concentrations from the Eductor (Table 14). Concentrations of cDCE and TCE in the B1 and B2 zones increase down-gradient, indicating that the on-site remedy may not be effectively reducing groundwater COCs or containing offsite migration in these aquifer zones. Shallow contamination from the source area may also be migrating vertically downward as it moves down-gradient.

A zone TCE concentrations have generally remained stable around 100 µg/L, except for those in well T-13A, which is closest to the source area and has shown a significant decrease in 2012 to below cleanup levels (Figure 20). The observed decrease in well T-13A likely corresponds with the down-gradient A zone injections that occurred in 2011. However, the impact does not appear to have been very far-reaching, as next nearest A zone down-gradient well T-8A has shown very little change in concentration since the 2011 injection. TCE concentrations in the other down-gradient wells shown in Figure 20 (T-15A, T-16A, T-9A) are generally stable.

Since the last FYR, B1 zone TCE concentrations (wells T-8B, T-9B, T-10B, and T-17B) remain above cleanup levels and have generally remained stable to slightly increasing with a slight dip observed in 2009 in all B1 wells except T-8B, indicating that the remedy is not effectively reducing concentrations in this aquifer zone.

B2 zone down-gradient wells T-10C and T-11C show a similar dip in TCE concentration in 2009, but concentrations have rebounded since then. B2 zone wells T-9C and T-11C show a delayed decline in TCE in 2010, but concentrations in those two wells have also similarly rebounded. The cause of the dip in TCE concentrations in 2009 and 2010 in the B1 and B2 zone wells is not readily apparent. Cheese whey injections occurred in the A zone wells during 2007-2008, but no injections were made into the B1 or B2 zone. The observed TCE decreases in the B1 and B2 zones around the time of the cheese whey injections may thus indicate that transmission is occurring between the A, B1, and B2 zones beneath the TRW OU. This may also explain increasing maximum TCE and cDCE concentrations observed in the B1 and B2 zones in the down-gradient area relative to the source area (Table 14). Furthermore, the latest B2 groundwater elevation contour plot (Figure 10) shows that B2 zone wells with high TCE concentrations (wells T-9C, T-10C, and T-11C) are almost directly down-gradient from the TRW source area.

6.4.6. TRW Indoor Air

Indoor air is not an original medium of concern for the TRW site. Since the 1991 ROD, EPA's understanding of vapor intrusion potential has increased; meanwhile, VOC concentrations in groundwater beneath the building have been significantly reduced through remedial activities, however continue to be present at the site above cleanup levels. Indoor air quality samples were collected at the site in 2003, 2004, and most recently in December 2013 to re-assess vapor intrusion potential.

COCs in the groundwater at TRW include multiple chlorinated compounds that are sufficiently toxic and volatile to cause a vapor intrusion concern. A comparison of 2013 A zone groundwater COC concentrations with groundwater screening levels protective for indoor air indicates that four groundwater COCs occur in sufficient concentration to cause a potential vapor intrusion concern. Table 15 lists the chemicals, maximum detected A zone groundwater concentrations, and respective applicable screening levels.

Table 15. TRW 2013 Maximum A Zone Groundwater Concentrations

COC	2013 A-Zone Maximum Groundwater Concentration (µg/L)	Commercial/Industrial VISL-calculated Groundwater Concentration (µg/L)	Risk basis
1,1-DCA	0.78	33	Cancer
1,2-DCB	**1800**	11,000	Noncancer
1,1-DCE	0.70	820	Noncancer
cDCE	**160,000**	No value	--
tDCE	86	1600	Noncancer
Freon 113	1.4	6100	Noncancer
PCE	2.3	65	Cancer
TCE	**8800**	7.4	Cancer
1,1,1-TCA	0.5	31,000	Noncancer
Vinyl chloride	**1800**	2.5	Cancer

Currently, a single two-story building overlies the VOC-impacted groundwater at the site. The building has been vacant since 2001 and is not equipped with mechanical ventilation, electricity, or plumbing. During remodeling activities conducted between 2001 and 2003 an extension to the building was completed overlying the former UST excavation. A 10 milliliter (mL) thick vapor barrier was installed beneath the portion of the building that was remodeled. The interior of the building remains unfinished. Because the building is currently unoccupied, there is currently no exposure risk due to vapor intrusion.

Results from the 2003 investigation prompted the installation of a temporary mechanical ventilation system. Follow-up indoor air sampling in 2004 confirmed that, in the absence of a ventilation system, concentrations of TCE detected in indoor air exceeded threshold limits for commercial/industrial exposure.

In December 2013, a vapor intrusion evaluation was conducted at the current site building. Sample locations included four indoor air samples, four sub-slab air samples, and two outdoor (ambient) air samples. Selected sample locations were placed near the Eductor and the elevator shaft to evaluate preferential pathways. The evaluation noted several additional preferential pathways, including monitoring wells inside the building, open electrical conduits, restroom drains, and an elevator shaft. Table 16 presents the maximum indoor air concentrations detected during the 2013 VI evaluation.

Table 16. TRW Maximum Detected 2013 Indoor Air Concentrations

Compound	Maximum Detected Indoor Air Concentration (µg/L)	Indoor Air EPA RSL (industrial) (µg/m^3)	DTSC –modified Indoor Air industrial screening levels (µg/m^3)	Risk Basis[1]
1,1-DCA	ND	7.7	–	Cancer
1,2-DCB	ND	880	–	Noncancer
1,1-DCE	ND	880	310	Noncancer
cDCE	2.0	–	31	Noncancer
tDCE	ND	260	–	Noncancer
Freon 113	0.98	130,000	–	Noncancer

Compound	Maximum Detected Indoor Air Concentration (µg/L)	Indoor Air EPA RSL (industrial) (µg/m^3)	DTSC –modified Indoor Air industrial screening levels (µg/m^3)	Risk Basis[1]
PCE	0.56	47	2.08	cancer
1,1,1-TCA	0.15	22,000	4,400	Noncancer
TCE	**7.7**	3.0	–	Cancer
Vinyl chloride	**0.52**	2.8	0.16	Cancer
1,4-DCB	ND	1.1	–	Cancer
Chlorobenzene	ND	220	–	Noncancer
chloroform	0.25	0.53	–	–
Freon 11	1.6	3100	–	–
Freon 12	2.7	440	–	–

Notes: Chemicals in *italics* are not COCs for the TRW OU.

Only two COCs (TCE and vinyl chloride) have indoor air concentrations that exceed one or both of the EPA and DTSC-modified industrial indoor air screening levels. Sub-slab TCE concentrations (data not shown) are substantially higher than indoor air concentrations, indicating that TCE in indoor air is likely VI related. In contrast, sub-slab concentrations for vinyl chloride are low or not detected, indicating that VC may not be VI related. However, given that the building is unoccupied, an above-ground source of VC is unlikely and may require further investigation to determine if a local background source has been overlooked.

Maximum TCE indoor air concentrations also exceed the EPA Region 9 Interim TCE Accelerated Response Action Level of 7 µg/m^3 for 10-hour workday exposure; however, no response is currently warranted as the building is unoccupied.

TCE is the only VI-related COC that presents a long-term risk above its cancer-based commercial/industrial screening level (3.0 µg/m^3 for TCE). The maximum detected concentration (7.7 µg/m^3) is still within EPA's acceptable lifetime excess cancer risk range of 3 to 300 µg/m^3 ($1x10^{-6}$ to $1x10^{-4}$ excess cancer risk, respectively). However, the Superfund protective risk range has been truncated by the noncancer-based screening level to 3 – 7 µg/m^3 (for 10-hour workday exposures), and maximum TCE indoor air concentrations exceed the upper boundary of this range. Currently the building is unoccupied and therefore no risk to occupants exists. In addition, a vapor intrusion mitigation system is currently being installed in the building (passive barrier and ventilation system with capability to be converted into an active system).

6.4.7. Offsite Groundwater

Groundwater data for the Offsite OU (nearby residential neighborhood in the vicinity of Duane and San Miguel Avenues) has not previously been evaluated through the EPA Five Year Review process. Groundwater monitoring in the Offsite OU has been conducted since the initial installation of the Offsite groundwater extraction system in the 1980s.

Groundwater data is currently collected by Locus Technologies (Locus), a contractor for Philips Semiconductor. Groundwater monitoring data associated with the site, with an emphasis on the most recent data, were reviewed and evaluated.

More than 100 groundwater monitoring wells and extraction wells are sampled annually at the OOU in coordination with the surrounding sites to provide a comprehensive regional data set for the area. The wells sampled in the OOU are distributed among the aquifer A, B1, B2, B3, B4, and B5 zones. In addition to the annual monitoring, a subset of extraction wells is sampled semi-annually to monitor remedial action performance.

Groundwater Flow

Water elevations are measured annually in a set of more than 100 monitoring and extraction wells at the OOU. Water elevation measurements in the OOU are coordinated with water elevation measurements in the surrounding sites (AMD 915, AMD 901/902, TRW, and Philips) to generate water elevation contours for the entire area. The general flow direction in all zones is north towards San Francisco bay, except where influenced by extraction wells. Figure 8, Figure 9, and Figure 10 show the 2012 water levels for the A, B1, and B2 zones.

For the time period 2006-2010, the vertical hydraulic gradients across the B2/B3, B3/B4, and B4/B5 aquitards have generally remained upward except for localized areas of downward gradient near extraction wells. Gradients were less consistent across the A/B1 and B1/B2 aquitards across the site (Locus, 2013).

Groundwater Chemistry

In 2013, TCE and cDCE are the only COCs that remain above their respective cleanup levels in one or more aquifers.

Table 17 presents the 2012 maximum concentrations observed in each aquifer within the OOU. COCs at the OOU are present above cleanup levels in the aquifer A, B1, B2, B3, and B4 zones. No COCs were detected in the B5 aquifer.

Table 17. OOU 2012 Maximum Groundwater Concentrations by Aquifer Zone

Offsite COC	Cleanup Level (µg/L)	A	B1	B2	B3	B4	B5
1,1-DCA	5	0.7	0.7	ND	ND	ND	ND
cDCE	6	**50**	**300**	**29**	**6.1**	3.7	ND
tDCE	10	3.4	4.6	ND	ND	ND	ND
1,1-DCE	6	ND	2.6	3.0	ND	ND	ND
Freon 113	1200	3.5	49	82	93	7.8	ND
PCE	5	ND	1.8	ND	ND	ND	ND
TCE	5	**210**	**550**	**550**	**620**	**98**	ND
1,1,1-TCA	200	ND	0.7	ND	ND	ND	ND
VC[a]	None	0.70	1.1	ND	ND	ND	ND

Notes: All concentrations are in µg/L. Bolded values indicate maximum concentrations that exceed the ROD-defined cleanup level. a – VC is not a ROD-defined COC for the OOU; data is included here for information purposes only.

October 2012 iso-concentration contours and individual well concentration data for TCE, one of the primary COCs at the site, are presented for the aquifer A, B1, B2, and B3 zones in Figures 23, 24, 25, and 26, respectively. In general, the highest VOC concentrations are located in the southern half of the OOU, and the majority of the contamination is restricted to the A, B1, and B2 zones. The B3 zone TCE contamination is restricted to the area south of Duane Avenue and represents a much smaller area than the TCE plumes observed in the overlying aquifers. The cDCE groundwater plumes (not shown) are generally much smaller in areal extent than the TCE plumes. Comparison of the 2012 iso-concentration contour maps to the 2009 contour maps reveals the following observations:

The down-gradient extent of the TCE plumes in the A and B1-zones appear to be stable, with the down-gradient most lobe of the plumes extending beyond the furthest north set of extraction wells. The furthest down-gradient B1 zone well with a TCE detection in 2009 (well COM63-B1; 32 ug/L) had a slightly higher TCE concentration in 2012 (47 µg/L). The lack of groundwater data directly downgradient of the respective TCE groundwater exceedances in COM49A and COM63-B1 is a data gap; the full extent of the downgradient TCE plumes in the A and B1 zones are therefore uncertain.

The B1 zone TCE plume also appears to have a cross-gradient extension near Blythe Avenue (well COM55-B1 in Figure 24). The full extent of this lobe of TCE contamination above the cleanup level is not well defined. A similar, albeit less prominent cross-gradient lobe of TCE contamination is found in the A zone aquifer (well COM55A in Figure 23). The source of the observed cross-gradient lobe is not readily apparent due to the lack of nearby monitoring wells directly upgradient of Blythe Avenue.

The B2 and B3 zone TCE plumes are smaller than the A and B1 zone TCE plumes, but neither appears to be shrinking nor expanding significantly since 2009. However, the full extent of the B2 zone TCE plume above the cleanup level is not well defined, specifically with respect to the western edge of the plume where it approaches or otherwise migrates beyond the Sunnyvale East Drainage Channel near Duane Avenue.

In summary, the GWETS appears to be maintaining plume control in the OOU, although significant reductions in COCs have not occurred since the last FYR. Significant decreases in the OOU COC concentrations may not happen until migration from off-site, up-gradient contaminant sources is reduced and/or eliminated.

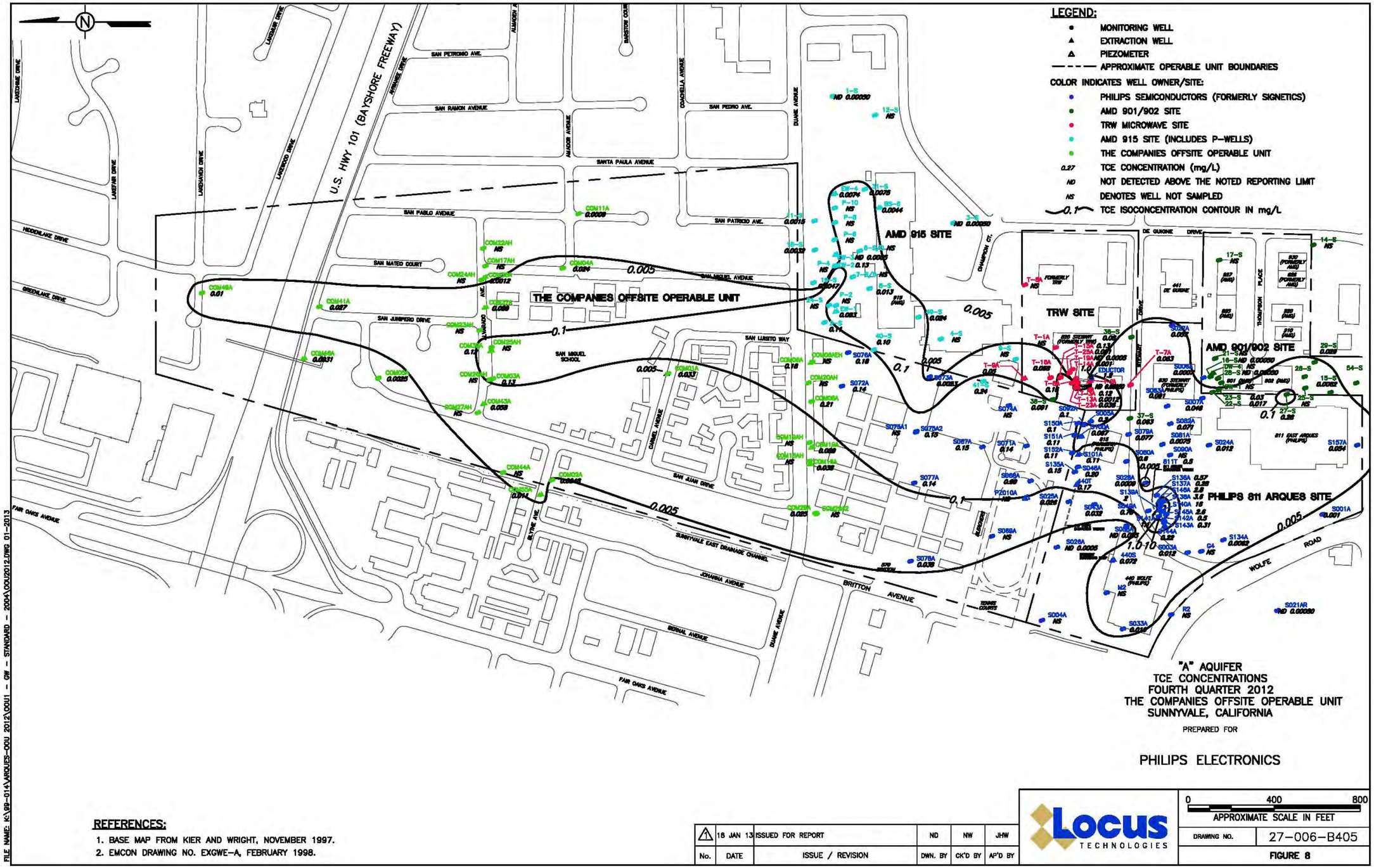

Figure 23. Offsite A zone TCE concentrations

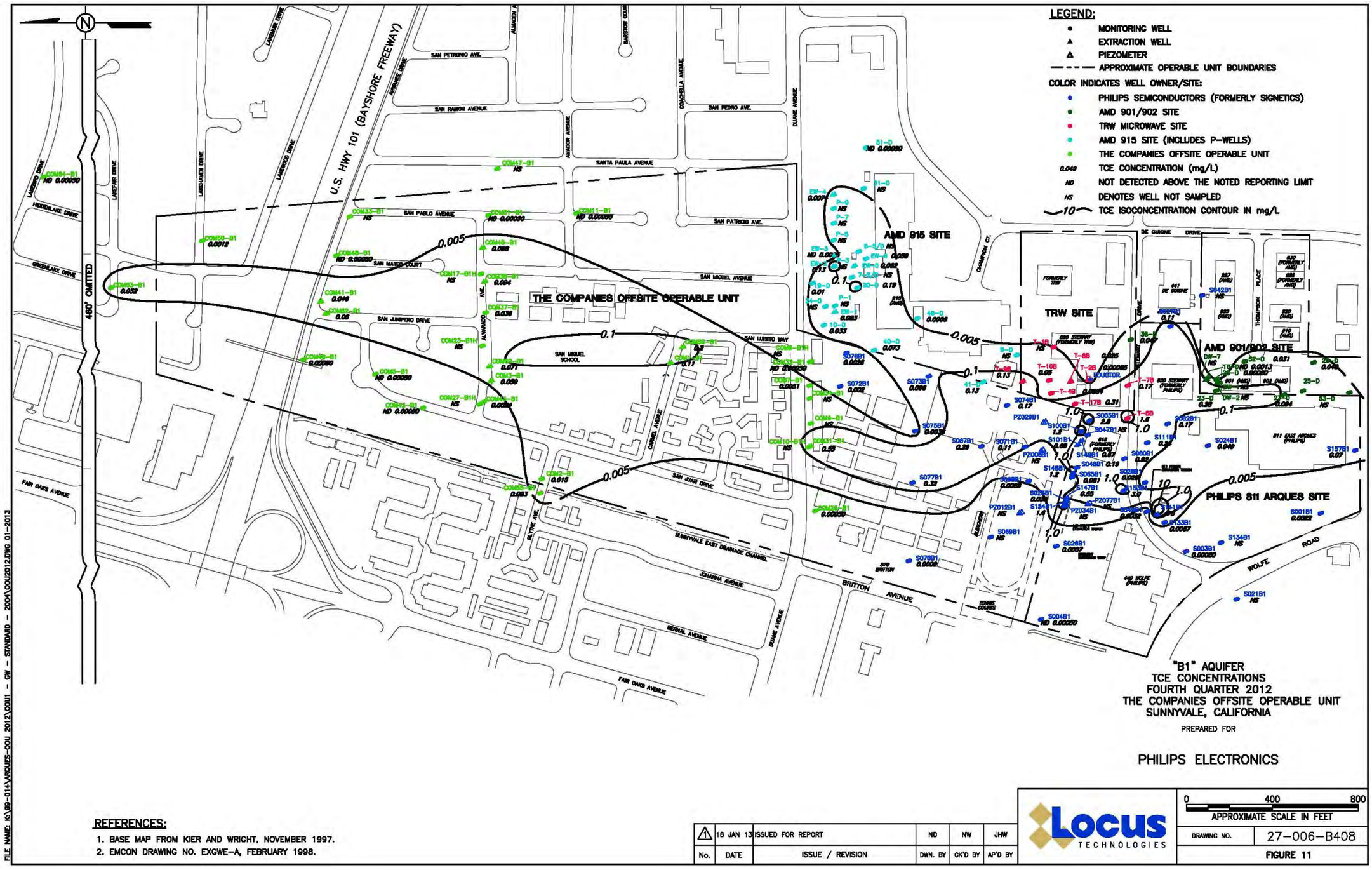

Figure 24. Offsite B1 zone TCE concentrations

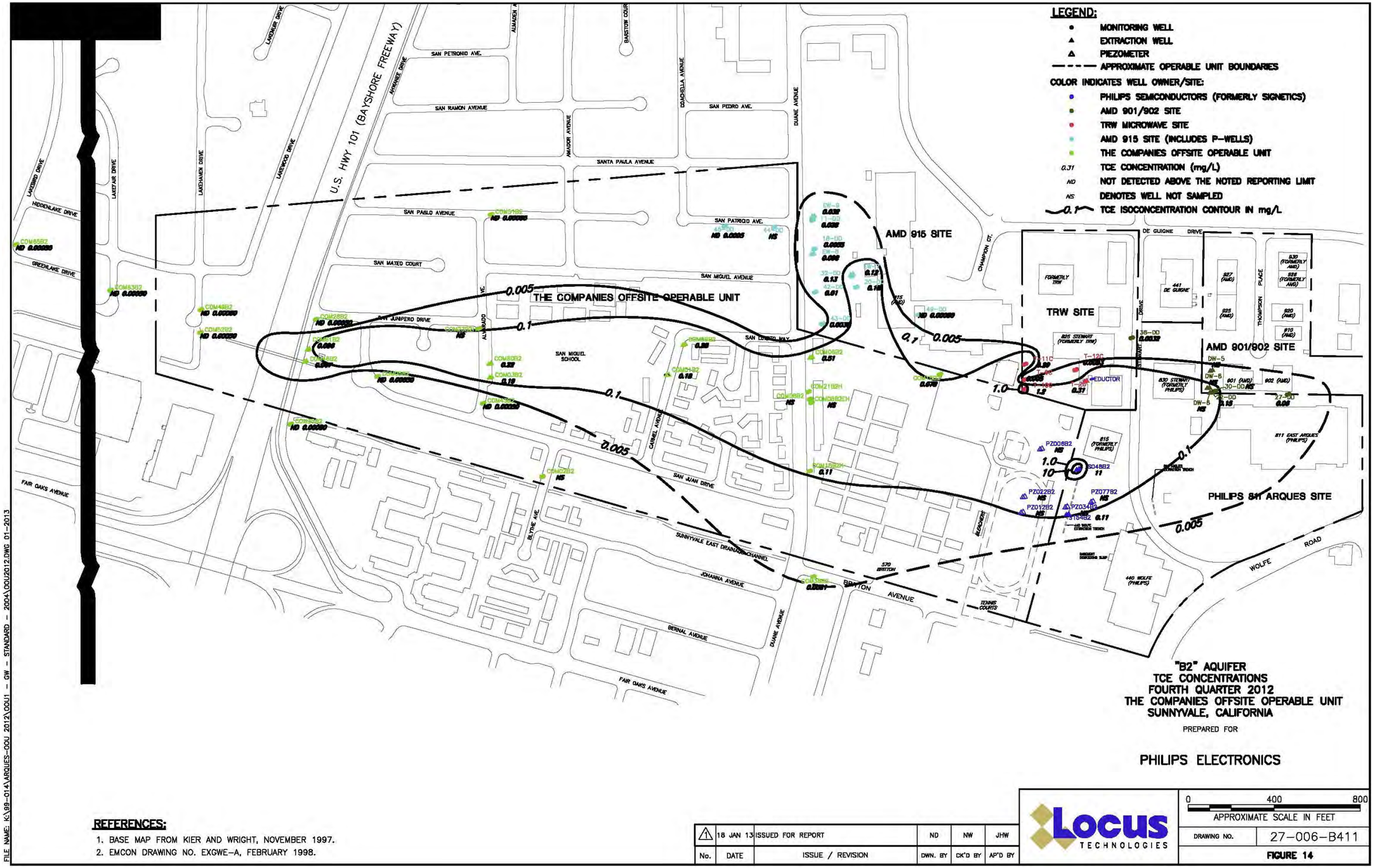

Figure 25. Offsite B2 zone TCE concentrations

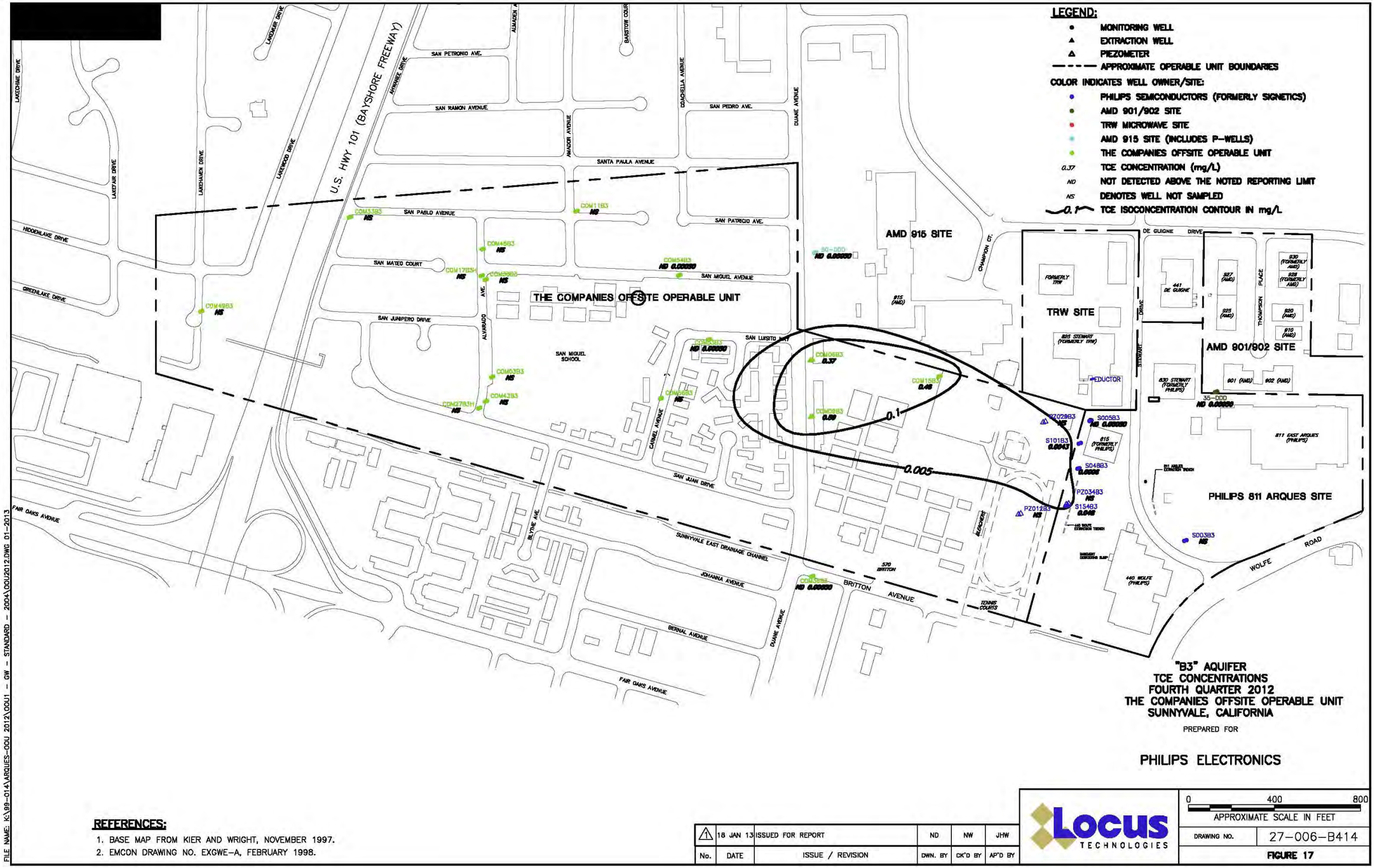

Figure 26. Offsite B3 zone TCE concentrations

6.4.8. Offsite OU Indoor Air

Indoor air is not an original medium of concern for the Offsite OU area. In February 2004, a soil gas investigation was conducted at the site to evaluate the potential for groundwater volatilization to indoor air in buildings overlying the groundwater plume (vapor intrusion); the results concluded that vapor intrusion-related indoor air concentrations due to COCs from the site are expected to be below applicable health criteria based on the understanding at that time of the potential of soil gas infiltration into overlying buildings. However, the soil gas concentrations were elevated in some areas south of Duane Avenue, and the modeled indoor air concentrations were in the range where uncertainties in the soil consistency and other model parameters could affect the results. Indoor air sampling was therefore conducted in 2004 to evaluate these uncertainties. An indoor air evaluation was conducted at a subset of buildings at the 790 East Duane Avenue property, which are currently occupied by a daycare/elementary school. Subsequently, Philips has conducted annual indoor air sampling at this property, all of which have been conducted with HVAC systems operating as usual. Indoor air sampling was also conducted in 2004 and 2005 at buildings at the 562 North Britton Avenue property.

The properties at 790 East Duane Avenue and 562 North Britton Avenue represent only a small portion of the OOU that overlies groundwater contaminated with TCE concentrations greater than 5 µg/L. Per the recent (December 2013) EPA Region 9 vapor intrusion recommendations, additional evaluation is needed at both the daycare/elementary school (including with HVAC systems turned off) and at other schools, residences and commercial buildings in the nearby neighborhood that overlies the TCE plume.

In January 2014, the Regional Board issued a formal request for a VI evaluation work plan to conform to the new EPA Region 9 vapor intrusion recommendations. Subsequent to this request, on August 7, 2014, lead agency oversight responsibilities for the Offsite OU and other OUs of the Triple Site was transferred from the Regional Board to EPA Region 9. Following this transfer, EPA issued a Notice of Deficiency (NOD) to the Responsible Parties (RPs) for the Triple Site, dated August 11, 2014, which requested the submittal of a vapor intrusion work plan for the Triple Site that incorporated expanded indoor air sampling in the neighborhood. At the time of this FYR preparation, the work plan was not available for review.

In lieu of updated indoor air data, available existing indoor air data and groundwater concentrations were compared to EPA Regional Screening Levels for indoor air and VISL-calculated groundwater concentrations protective of indoor air. Since the OOU encompasses properties with both residential and commercial uses, the more conservative residential screening levels were used in this assessment.

Evaluation of Indoor Air

Table 18 compares the 2013 maximum detected indoor air concentrations measured at the daycare/elementary school in 2013 to the EPA and California-modified indoor air residential and industrial screening levels. The indoor air concentration of TCE just slightly exceeds the EPA residential RSL of 0.43 µg/m^3. However, some previous sampling events at the daycare/elementary school showed elevated indoor air TCE concentrations. In 2004, a TCE concentration of 4.6 µg/m^3 was measured in Building G at the daycare/elementary school. In 2012, a TCE concentration of 1.9 µg/m^3 was measured

in Building H (this location subsequently showed a lower TCE concentration of 0.44 µg/m^3 during the 2013 sampling event). However, sampling sets were limited (including by lack of pathway sample collection) and numerous HVAC system deficiencies continue to be observed during indoor air sampling events that may contribute to the levels of COCs measured.

Sampling results from the school on 562 North Britton Avenue ranged in 2004 and 2005 from non-detectable to exceedances of the RSL and up to 260 µg/m^3, however the higher concentrations above the EPA Region 9 Interim TCE Indoor Air Accelerated Response Action Level were attributed to an indoor source at the time associated with construction activities. However, information about building conditions and HVAC operation during the 2004 and 2005 event was unavailable for this five year review.

Table 18. OOU Indoor Air Concentrations Compared to RSLs

COC	2013 Maximum Detected Indoor Air Concentration (µg/L)	Indoor Air EPA RSL (residential) (µg/m^3)	DTSC-modified Indoor Air residential screening level (µg/m^3)	Indoor Air EPA RSL (industrial) (µg/m^3)	DTSC –modified Indoor Air industrial screening levels (µg/m^3)	Risk Basis[1]
1,1-DCA	ND	1.5	–	7.7	–	Cancer
cDCE	ND	–	7.3	–	31	Noncancer
tDCE	ND	63	–	260	–	Noncancer
1,1-DCE	ND	210	73	880	310	Noncancer
Freon 113	0.65	31,000	–	130,000	–	Noncancer
PCE	ND	9.4	0.41	47	2.08	Cancer
TCE	**0.44**	0.43	–	3.0	–	Cancer
1,1,1-TCA	ND	5,200	1040	22,000	4,400	Noncancer

1 – Risk basis indicates whether the RSL is driven by cancer or non-cancer toxicity.
Notes: ND – not detected; Bold – values shown in bold exceed a residential or industrial indoor air RSL.

Based on the results on the 2013 indoor air sampling event, indoor air concentration of VOCs at the daycare/elementary school due to vapor intrusion are considered protective of human health during the HVAC system conditions at the time of sampling. In addition, the 2004 and 2005 indoor air sampling at the school at 562 North Britton Avenue, are also considered protective, in part because the exceedences were associated with construction at the building and are not expected under current operations. However, information about the operation of the HVAC at the time of sampling is unknown. Per the recent EPA Region 9 vapor intrusion recommendations, additional evaluation is needed at both this school (including with HVAC systems turned off) and at other schools, residences and commercial buildings in the nearby neighborhood that overlies the TCE plume.

Evaluation of Groundwater data

Indoor air data is unavailable for the majority of the properties within the OOU. The vapor intrusion risk was therefore evaluated by comparing maximum groundwater concentrations in the uppermost aquifer A zone to the VISL-calculated groundwater concentrations protective of indoor air for a residential scenario (Table 19.) TCE exceeds the VISL groundwater value, indicating that the potential exists for

indoor air risk due to the groundwater contamination. This exceedance supports the need to conduct further indoor air assessments at the site.

Table 19. OOU Maximum A Zone Groundwater Concentrations

COC	2013 A-Zone Maximum Groundwater Concentration (µg/L)	VISL-calculated Groundwater Concentration (µg/L)	VISL value risk basis
1,1-DCA	0.7	6.6	Cancer
cDCE	50	--	--
tDCE	3.4	380	Noncancer
1,1-DCE	ND	200	Noncancer
Freon 113	3.5	1500	Noncancer
PCE	ND	13	Cancer
TCE	**210**	1.1	Cancer
1,1,1-TCA	ND	7400	Noncancer

Values shown in bold are greater than the VISL-calculated groundwater concentration screening level.

6.5. Site Inspection

Site inspections of the AMD 901/902 and TRW OUs were conducted on October 24, 2013. Additionally, the EPA and Regional Board Project Managers conducted an inspection of the daycare/elementary school and the school on 562 North Britton Avenue on September 30, 2013 to identify potential indoor air sampling locations. EPA conducted subsequent visual inspections from public right-of-way locations in the Offsite OU residential neighborhood in 2014. The site inspection checklists from the October 24, 2013 site inspections are presented in Appendix D and are summarized below. Photos from the site inspections are provided in Appendix E.

AMD

Participants at the AMD 901/902 site inspection included Melanie Morash (RPM) from EPA, Max Shahbazian from the Regional Board, Do Cao (site manager) from AMD, Peter Bennett (lead hydrogeologist) from Haley and Aldrich, Inc. (HAI), Michael Calhoun (senior specialist, hydrogeologist) from HAI, and Ellen Engberg and Aaron King from USACE.

The site inspection determined that the AMD site is in good condition; monitoring wells and treatment system equipment appeared to be properly secured, and there was no evidence of vandalism.

TRW

Participants at the TRW site inspection included Melanie Morash (RPM) from EPA, Max Shahbazian from the Regional Board, Klaus Rohwer (principal geologist) of Equipoise Corporation, Rebecca Mora (senior engineer) from AECOM, and Ellen Engberg and Aaron King from USACE.

The participants walked the site to evaluate current conditions. Except for some minor settlement issues at one well (see photographs), the monitoring wells appeared to be in good condition. Vagrants and other homeless people have been observed on the site, but all wells and the building were secured. Incidents of

vandalism have decreased since the former SVE system equipment was removed from the fenced enclosure at the north side of the OU. In summary, the site appeared to be in good condition.

6.6. Interviews

During the FYR process, interviews were conducted with parties impacted by the Site, including the current landowners and regulatory agencies involved in Site activities or aware of the Site. Consultants for the AMD and TRW site owners were interviewed during the site visits on October 24, 2013. Complete interview documents are included in Appendix C and are summarized below.

The AMD interviewees included Peter Bennett (lead hydrogeologist) and Michael Calhoun (senior specialist/hydrogeologist) of Haley & Aldrich, contractor for the responsible party. Do Cao, the AMD site manager, was also interviewed. The interviewees stated that the ISB treatments are generally functioning well. Since 2011, ISB has been operated in pulses (non-continuously). Concentration rebounding has been observed; therefore, the ISB project may need to run longer than originally expected. Injection and extraction locations are rotated in order to improve lateral distribution of the carbon substrate. No other problems with O&M were cited.

The TRW interviewees included Klaus Rohwer, principal geologist for Equipoise Corporation, and Rebecca Mora, senior engineer for AECOM. AECOM is a contractor for Northrop Grumman; Mr. Rohwer is a consultant hired by Northrup Grumman to act as an independent project manager for the site. The interviewees stated groundwater concentrations are decreasing in the source area where EAB treatments are functioning very well. Despite the source area being controlled via EAB, contamination leaving the site is the same as contamination entering up-gradient. The site owners would like to obtain a determination of no further action for the remediation, but this has been difficult due to contamination from neighboring sites. Vandalism was a concern until the remaining old system components were removed.

6.7. Institutional Controls

AMD

The 1991 ROD requires a deed restriction to be included in the remedy to prohibit the installation of onsite wells until the groundwater remediation is completed. A covenant to restrict use of property at the Site at 901/902 Thompson Place was recorded May 20, 2005 by Santa Clara County. The covenant includes the following restrictions:

- Prohibits residential development for human habitation;
- Prohibits construction or use of medical facilities, day-care centers, or schools;
- Prohibits use of groundwater or excavation of soils without prior approval of the Regional Board.

A title search was not conducted as part of this FYR to confirm that the restrictive covenant on the Site remains to address impacts from remaining contamination.

TRW

The 1991 ROD requires a deed restriction to be included in the remedy to prohibit the use of groundwater on the Site until remediation is completed. A covenant to restrict use of property at the Site at 825 Stewart Drive was recorded August 20, 1992 by Santa Clara County. The covenant includes the following restrictions:

- Prohibits use of groundwater or excavation of soils without prior approval of the Regional Board.

A title search was not conducted as part of this FYR to confirm that the restrictive covenant on the Site remains to address impacts from remaining contamination. The existing covenant was recorded prior to the passage of California Civil Code section 1471 in 1992 and subsequent amendment in 2002. A new restrictive covenant consistent with current California law may be needed.

OOU

Currently, shallow groundwater concentrations of TCE and cDCE remain elevated above cleanup levels. The selected remedy for the Offsite OU did not include institutional controls to prevent use of the shallow groundwater. However, the county water district (SCVWD) regulates the construction, destruction, and maintenance of wells under Ordinance 90-1, and well installations are prohibited in the county without a permit from the SCVWD.

Table 20 summarizes the ICs associated with each OU and medium.

Table 20. Institutional Controls Summary Table

Media	ICs Called for in the Decision Documents	Impacted OU	IC Objective	Instrument in Place	Notes
Ground-water	Yes	AMD 901/902	Restrict installation of ground water wells and ground water use on the Site	2005 Restrictive Covenant	Existing covenants were recorded prior to the passage of California Civil Code (CCC) section 1471; updated/new covenants are still required for both OUs.
	Yes	TRW	Restrict groundwater use on the Site	1992 Restrictive Covenant	
Ground-water	No	Offsite OU	Prohibit well installations without a permit from county water district	Ordinance 90-1	Enforced by the SCVWD.
Soil	No	AMD 901/902	None	2005 Restrictive Covenant	Although the ROD did not require a deed restriction on soil use, the 2005 covenant included soil excavation restrictions.

7. Technical Assessment

7.1. Question A: Is the remedy functioning as intended by the decision documents?

No, the selected remedies at the AMD and TRW OUs are pump and treat remedies. These systems are not currently being operated. However, the in-situ technologies currently being implemented at the AMD and TRW OUs are providing protectiveness. The selected remedy for the Offsite OU is currently in operation, but the protectiveness cannot be determined at this time due to vapor intrusion concerns.

7.1.1. AMD

Remedial Action Performance. Groundwater data indicate that five COCs (PCE, TCE, cDCE, tDCE, and VC) remain at levels above cleanup standards at the site in one or more of the aquifer A, B1, and B2 zones. Remedial efforts have greatly reduced TCE concentrations in the original source areas since implementation of the remedy and subsequent ISB. TCE degradation products such as cDCE and vinyl chloride have seen recent increases in the ISB treatment areas. The highest concentrations of cDCE, tDCE, TCE, and vinyl chloride occur within the source area, indicating that the former source area is still contributing to groundwater contamination. The notable exception is PCE, for which the maximum concentration occurs in the up-gradient A-zone aquifer.

In general, all down-gradient COC concentrations are lower than the up-gradient and former source area groundwater concentrations, indicating that the on-site treatment system is effectively reducing groundwater COCs. Only cDCE and TCE still remain in down-gradient groundwater at concentrations that exceed their cleanup levels. A subset of COCs, particularly cDCE, PCE, and TCE continue to appear in the up-gradient wells at concentrations significantly exceeding the cleanup levels. Achievement of cleanup goals will remain a challenge as long as the migration of these COCs from up-gradient sources persists.

Opportunities for Optimization. The ISB may benefit from optimization to produce continued significant COC concentration decreases in the source area. Recent COC concentration trends appear to be stable or rebounding.

Early Indicators of Potential Issues. No early indicators of potential issues were identified during this FYR.

Implementation of Institutional Controls and Other Measures. A 2005 covenant prohibits residential development for human habitation; construction or use of medical facilities, day-care centers, or schools; or use of groundwater or excavation of soils without prior approval of the Regional Board. No activities were observed at these two OUs that violate the covenant. A title search was not conducted as part of this FYR to confirm if the existing restrictive covenant has been updated or remains in place to address impacts from remaining contamination.

7.1.2. TRW

Remedial Action Performance. Remedial efforts have reduced COC concentrations in source areas and across the dissolved plume at the TRW OU; however, five COCs (1,2-DCB, cDCE, tDCE, TCE, and VC) remain above their respective cleanup standards in one or more of the aquifer shallow zones. Overall, remedial efforts have substantially reduced COC concentrations in the TRW source area in the aquifer A, B1, and B2 zones since implementation of the remedy. The highest COC concentrations occur in the shallow Eductor in the source area, indicating that the former source area continues to contribute to site groundwater contamination. Concentrations of TCE and cDCE increase in the down-gradient B1 and B2 zones, suggesting that the on-site remedy may not be effectively containing offsite migration.

Migration of off-site, up-gradient contaminants onto the site continues, and ultimate achievement of cleanup goals will remain a challenge as long as the migration of COCs from up-gradient sources persists.

Opportunities for Optimization. The EAB at TRW may benefit from an optimization that targets B1 and B2 zone contamination, especially in the down-gradient area. Additional ISB optimization targeting the source area may also be needed to reduce observed source area and Eductor groundwater concentrations.

Early Indicators of Potential Issues. The lack of monitoring in the B3 zone at the TRW site is a data gap. Characterization of B3 zone groundwater is necessary to determine whether the former source area at TRW may be a source of contamination observed in the B3 zone of the adjacent Offsite OU.

Implementation of Institutional Controls and Other Measures. A restrictive covenant was recorded in 1992 that prohibits the use of groundwater until cleanup levels are achieved. No activities were observed at these two OUs that violate the institutional controls. In the previous FYR, a new restrictive covenant was recommended because the existing covenants were recorded prior to the passage of California Civil Code section 1471. A new covenant has yet to be recorded.

7.1.3. OOU

Remedial Action Performance. Groundwater data indicate that TCE and cDCE remain at levels above cleanup standards in the aquifer A, B1, B2, B3, and B4 zones. No COCs were detected in the B5 aquifer. The majority of the contamination is restricted to the A, B1, and B2 zones. Plume boundaries appear to be stable, indicating that the GWETS is maintaining control of the plume extent. Significant reductions in the OOU COC concentrations may not occur until migration from off-site, up-gradient contaminant sources is reduced and/or eliminated.

System Operations/O&M. The remedy in the OOU continues to function as intended by the ROD. The Offsite GWETS continues to contain down-gradient contamination migration from up-gradient sites; the GWETS is also successfully containing the groundwater contamination to the shallow groundwater zones (A, B1, B2, and B3 zones). In 2010, extracted OOU groundwater was re-routed to a treatment system located at the Philips OU. Treated effluent is discharged under an NPDES permit. Sufficient annual groundwater monitoring continues to monitor the plume extents.

Opportunities for Optimization. No opportunities for optimization were identified during this FYR.

Early Indicators of Potential Issues. Groundwater concentrations of TCE are high enough to cause vapor intrusion concerns. Additional VI evaluations should be performed.

Implementation of Institutional Controls and Other Measures. The ROD does not require ICs for the Offsite OU, although ICs would provide an additional layer of protection. The SCVWD regulates the construction, destruction, and maintenance of wells in Santa Clara County under Ordinance 90-1; well installations are prohibited without a permit from the SCVWD.

7.2. Question B: Are the exposure assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of Remedy Selection Still Valid?

Yes, the exposure assumptions and toxicity data used at the time are still valid.

There have been no changes to ARARs that would affect the protectiveness of the Site groundwater remedy. Groundwater cleanup standards have not changed since the ROD was issued. No new contaminants have been identified since the ROD.

Land use has not changed at the site since the last FYR. The current and future exposure pathways identified in the ROD are still valid assumptions. An environmental covenant is in place that prohibits installation of groundwater wells for domestic use.

Vapor intrusion was evaluated previously in the AMD and TRW OUs, and at one school in the Offsite OU. Vapor intrusion evaluation at the AMD OU suggests that there are no potential indoor air exposures due to groundwater contamination at this OU, however the need for a vapor intrusion evaluation at the remaining seven buildings at the site upgradient from the original source was not assessed.

Vapor intrusion evaluation at the TRW OU indicates that TCE concentrations in indoor air near the former source area present an inhalation risk, however the building is unoccupied and a vapor intrusion mitigation system is currently being installed in the building.

Vapor intrusion has only been evaluated for one small portion of the OOU. For the daycare/elementary school buildings sampled annually, recent indoor air sampling results suggest that the risk due to vapor intrusion is acceptable as long as HVAC systems are functioning. Groundwater contamination in the OOU indicates the potential for vapor intrusion risk on a much larger site-wide scale. Additional vapor intrusion assessment is recommended at the OOU.

The remedies for the AMD, TRW, and Offsite OUs continue to make progress toward groundwater restoration. ISB and EAB at AMD and TRW, respectively, continue to attain decreases in site contamination. The GWET systems appear to be containing contaminants and preventing further migration off-site.

Exposure to groundwater is prevented at the AMD and TRW OUs via ICs, although the lack of ICs in the Offsite OU allows the potential for exposure to contaminated groundwater. Potential risk due to volatilization of vapors from groundwater contaminated with COCs is still a concern.

7.3. Question C: Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

There is no other information known at this time that calls into question the protectiveness of the remedy.

7.4. Technical Assessment Summary

One or more COCs remain at concentrations above the cleanup standards in the AMD, TRW, and Offsite OUs. Of concern in all OUs is the occurrence of contaminants that continue to migrate on-site from up-gradient, off-site locations. The technical assessment is summarized for each OU below.

7.4.1. AMD

Soil excavation was completed in 1992, followed by a No Further Action letter issued by the Regional Board in 2008. The groundwater remedy as described in the ROD is no longer operating. The GWETS began operation in 1983, but has been discontinued due to declining effectiveness. Portions of the GWETS are now used in conjunction with in-situ bioremediation (ISB) injections to inject and circulate carbohydrate amendment. When in operation, extracted groundwater is treated with granular activated carbon (GAC) and re-injected at the site. A revised FFS was submitted in October 2013 and is awaiting approval from the Regional Board and EPA. On August 7, 2014, lead agency oversight responsibility for this and the other OUs of the Triple Site was transferred from the Regional Board to EPA Region 9. EPA will use the evaluation of alternatives in the FFS to select a final remedy for the site.

Five chemicals of concern (COCs) remain at concentrations above groundwater cleanup standards at the site. Contamination is confined to the shallow groundwater-bearing zones (A, B1, and B2 zones). Remedial efforts have greatly reduced TCE concentrations in the original source areas. TCE degradation products cDCE and vinyl chloride have seen recent increases in the ISB treatment areas, indicating that degradation is occurring, but that it is incomplete. Contamination from off-site, up-gradient sources continues to be an issue.

There have been no changes to groundwater cleanup levels since the ROD. Toxicity revisions have occurred for several chemicals, but the revisions do not affect protectiveness. Land use has not changed since the last FYR. Exposure pathways for soil and groundwater are being controlled through institutional controls. A 2005 covenant prohibits residential development for human habitation; construction or use of medical facilities, day-care centers, or schools; or use of groundwater or excavation of soils without prior approval of the Regional Board. The current status of the existing covenant was not investigated in this FYR.

Vapor intrusion was most recently evaluated in 2014 at the self-storage warehouse occupying the former site of the 901 and 902 Thompson Place buildings; results indicate that potential indoor air exposures due to site groundwater contamination are not a concern. However, the need for vapor intrusion evaluations was not assessed for the remaining seven buildings currently occupying the site located upgradinet for the former source area, and possibly associated with an upgradient source.

7.4.2. TRW

Five COCs remain at concentrations above groundwater cleanup standards at the site. Contamination is contained in the shallow groundwater-bearing zones (A, B1, and B2 zones). VOC concentrations are declining over time but remain significantly above cleanup levels in the source area, indicating that the source area may still be contributing to groundwater contamination. Concentrations of TCE and cDCE increase in the down-gradient B1 and B2 aquifers, suggesting that the on-site remedy may not be effectively containing off-site migration. Migration of contamination from off-site, up-gradient sources continues to be a concern.

Groundwater extraction and treatment occurred at the site between 1986 and 2001. Between 1993 and 1998, soil vapor extraction and treatment (SVET) was also used to facilitate cleanup of residual contamination in the unsaturated zone in the vicinity of the former underground storage tank (UST) area. Due to declining effectiveness, the groundwater extraction and treatment portion of the remedy was discontinued in 2001. The Responsible Party (RP) subsequently proposed enhanced anaerobic biodegradation (EAB) as a revised remedy for groundwater. Pilot testing for EAB began in 2000 and was expanded in 2005. EAB has achieved some success in reducing COC concentrations, although rebound has been observed. A draft FFS was completed in 2011 and it is anticipated the document will be finalized once the vapor intrusion investigation and mitigation project has been completed at the on-site building. On August 7, 2014, lead agency oversight responsibility for this and the other OUs of the Triple Site was transferred from the Regional Board to EPA Region 9.

There have been no changes to groundwater cleanup levels since the ROD. Toxicity revisions have occurred for several chemicals, but the revisions do not affect protectiveness. Land use has not changed since the last FYR. Exposure pathways for soil and groundwater are being controlled through institutional controls. A restrictive covenant that prohibits use of groundwater or excavation of soils was recorded in 1989. However, a new restrictive covenant may need to be completed as the existing covenant was recorded prior to the passage of California Civil Code section 1471, which was passed in 1995 and established the framework for environmental covenants in California.

Vapor intrusion was most recently evaluated in 2013; results indicate that potential indoor air exposures due to TCE in site groundwater contamination may become a concern if the building (currently unoccupied) above the former source area becomes occupied. To address potential exposures, a vapor intrusion mitigation system (passive barrier and ventilation system, with capability to be converted to an active system) is being installed in the building.

7.4.3. Offsite

Groundwater data indicate that two COCs (TCE and cDCE) remain at levels above cleanup standards in the shallow aquifers. The remedy is effectively containing contaminants migrating from up-gradient sources and is preventing further down-gradient migration.

The groundwater extraction network has been expanded since the ROD and currently operates with 29 extraction wells. Until 2010, extracted groundwater from the OOU was processed at the treatment facility located at 915 DeGuigne Drive and discharged under a NPDES permit. Starting in October 2010 and continuing through the present time, extracted groundwater is now routed to the treatment facility located at the Philips site; treated effluent is discharged to the Sunnyvale East Channel in accordance with NPDES Permit No. CAG912003.

There have been no changes to groundwater cleanup levels since the ROD. Toxicity revisions have occurred for several chemicals, but the revisions do not affect protectiveness. Land use is primarily residential, with four schools. Institutional controls are in place to prevent well installations in Santa Clara County, and a municipal water supply exists for the area.

A vapor intrusion assessment was most recently conducted at the 790 East Duane Avenue property in 2013, which is currently occupied by a daycare/elementary school. Based on the results of this indoor air sampling event, the levels of VOCs at the daycare/elementary school due to vapor intrusion are considered protective of human health during the HVAC system conditions at the time of sampling. Indoor air sampling was also conducted in 2004 and 2005 at buildings at the 562 North Britton Avenue property.

The properties at 790 East Duane Avenue and 562 North Britton Avenue represent only a small portion of the OOU that overlies groundwater contaminated with TCE concentrations greater than 5 µg/L Concentrations of COCs in groundwater indicate the potential for vapor intrusion risk on a much larger site-wide scale. Additional vapor intrusion assessment is recommended at other schools, residences and commercial buildings in the nearby neighborhood that overlies the TCE plume.

8. Issues

Table 21 summarizes the current issues for the Site.

Table 21. Issues for the AMD, TRW, and Offsite OUs

OU	Issue	Affects Current Protectiveness (Yes or No)	Affects Future Protectiveness (Yes or No)
AMD	The remedy selected for the Site is no longer being operated.	No	Yes
TRW	The remedy selected for the Site is no longer being operated.	No	Yes
TRW	Groundwater contamination is not adequately characterized in the source area and downgradient B3 zone.	No	Yes

Offsite	Groundwater concentrations in the off-site plume indicate a potential for vapor intrusion in an area with 4 schools and over 100 residences. There has been limited indoor air sampling in the area.	Unknown	Yes

In addition, the following are recommendations that would improve site characterization knowledge, but do not affect current protectiveness, were identified during the Five-Year Review:

Sitewide

- Achievement of groundwater cleanup goals will remain a challenge as long as the migration of COCs from up-gradient, off-site sources persists. Coordinate with the Regional Board on a broader regional strategy for groundwater remediation and identify and investigate optimization opportunities for remediation of off-site contamination sources. This coordination effort will facilitate achievement of cleanup goals, which remains a challenge due to the persistent migration of COCs onto the site from up-gradient sources.
- Robust Operations, Maintenance, and Monitoring (OM&M) Plans should be developed and implemented at the daycare/elementary school buildings, as well as any other buildings at the Triple Site for which HVAC-based vapor intrusion remedies have been identified as appropriate.

AMD

- Evaluate and implement modifications to the existing in-situ bioremediation treatment remedy to optimize contaminant biodegradation and produce continued significant COC concentration decreases in the source and down-gradient areas.
- Assess the need for vapor intrusion evaluations at the remaining seven buildings currently occupying the site that are upgradient of the former source area.

TRW

- Source area groundwater continues to show high concentrations of TCE in the B1 and B2 aquifer zones, despite in-situ bioremediation activities. Continue in-situ treatments to further reduce source area COC concentrations, and investigate and implement opportunities for optimization.

Offsite OU

- Little progress towards meeting the groundwater cleanup goals has been made in the Offsite OU during the previous Five-Year Review period. Evaluate groundwater cleanup alternatives (such as the in-situ bioremediation activities currently being conducted at the AMD and TRW OUs) at the Philips site OU to accelerate the timeframe for groundwater restoration.
- The full down-gradient extent of the TCE plumes in the A and B1 zones is uncertain due to the lack of monitoring wells directly down-gradient (north) of the most-downgradient (northernmost) groundwater exceedances. Additional monitoring wells north of the northernmost set of extraction wells are recommended to fully characterize the extent of the TCE contamination plumes in the A and B1 zones.

- The westernmost extent of the TCE plumes in the B1 and B2 zones is uncertain due to the lack of monitoring wells in the vicinity of the Sunnyvale East Drainage Channel. Additional monitoring wells are recommended in this area to fully characterize the westernmost extent of the TCE contamination plumes in the B1 and B2 zones.

Table 22 provides recommendations to address the issues at the AMD, TRW, and Offsite OUs.

Table 22. Recommendations to Address Issues

OU	Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Yes or No)	
						Current	Future
AMD	The remedy selected for the Site is no longer being operated.	Select a revised cleanup plan and prepare a revised EPA decision document.	PRP	EPA	09/2016	No	Yes
TRW	The remedy selected for the Site is no longer being operated.	Select a revised cleanup plan and prepare a revised EPA decision document.	PRP	EPA	09/2016	No	Yes
TRW	Ground-water contamination is not adequately characterized in the source area and down-gradient B3 zone.	Add source area and down-gradient B3 zone wells to the suite of annual monitoring wells.	PRP	EPA	09/2015	No	Yes
Off-site	Groundwater concentrations in the off-site plume indicate a potential for vapor intrusion in an area with 4 schools and over 100 residences. There has been limited indoor air sampling in the area.	Conduct vapor intrusion assessments at the site.	PRP	EPA	09/2016	defer	Yes

9. Protectiveness Statements

9.1. AMD

The remedy at the AMD 901/902 OU currently protects human health and the environment by controlling exposure pathways that could result in unacceptable risks. However, in order for the remedy to be protective in the long-term, the ROD will need to be amended to reflect a revised final groundwater remedy for the site since the remedy selected in the ROD is no longer operating.

9.2. TRW

The remedy at the TRW OU currently protects human health and the environment because exposure pathways for soil and groundwater are being controlled. Exposure pathways to contaminated groundwater that could result in unacceptable risks are prevented through an environmental covenant. The risk due to vapor intrusion is controlled as long as the building remains unoccupied and the exposure pathway remains incomplete. However, in order for the remedy to be protective in the long-term, the ROD will need to be amended to reflect a revised final soil and groundwater remedy for the site since the remedy selected in the ROD is no longer operating.

9.3. Offsite OU

A protectiveness determination of the remedy at the OOU cannot be made at this time until further information is obtained. Vapor intrusion assessments must be conducted to determine if indoor air pathways are complete. If unacceptable levels are encountered in a particular building, mitigation plans will be implemented to ensure that levels of VOCs in indoor air are protective. EPA has begun a vapor intrusion assessment and expects that these activities will take approximately two years to complete, at which time a protectiveness determination can be made.

10. Next Review

This is a statutory Site that requires ongoing FYRs as long as waste is left on site that does not allow for unlimited use and unrestricted exposure. The next FYR will be due within five years of the signature date of this FYR.

Appendix A: List of Documents Reviewed

General/Other

City of Sunnyvale. 2012 Water Quality Report. Accessed 23 April 2014 from http://sunnyvale.ca.gov/Departments/EnvironmentalServices/Water.aspx

DTSC, 2013. Human Health Risk Assessment Note Number 3. California DTSC, Office of Human and Ecological Risk (HERO), May 21.

EPA, 1991. Record of Decision, Advanced Micro Devices #901/902, Signetics, TRW Microwave. Combined Superfund Sites, Sunnyvale, California, September 11.

HAI, 2013. Technical Status and NPDES Self-Monitoring Report, Reporting Period January through March 2013, CIWQS Place ID: 203805, 915 DeGuigne Drive, Sunnyvale, California, May 15.

AMD 901/902

AMEC, 2009a. In Situ Bioremediation Program, January through March 2009 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, April.

AMEC, 2009b. In Situ Bioremediation Program, April through June 2010 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, July 31.

AMEC, 2009c. In Situ Bioremediation Program, July through September 2009 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, October 31.

AMEC, 2010a. Combined 2009 Annual Groundwater Monitoring and Annual *In Situ* Bioremediation Program Report, Former 901/902 Thompson Place, Sunnvyale, California, January 29, 2010.

AMEC, 2010b. In Situ Bioremediation Program, January through March 2010 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, April 30.

AMEC, 2010c. In Situ Bioremediation Program, April through June 2010 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, July 9.

AMEC, 2010d. In Situ Bioremediation Program, July through September 2010 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, October 29.

AMEC, 2011a. Combined 2010 Annual Groundwater Monitoring and Annual *In Situ* Bioremediation Program Report, Former 901/902 Thompson Place, Sunnvyale, California, January 31, 2011.

AMEC, 2011b. Focused Feasibility Study, Former 901/902 Thompson Place, Sunnyvale, California. AMEC Geomatrix, Inc. May 2011.

AMEC, 2011c. In Situ Bioremediation Program, January through March 2011 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, April 29.

AMEC, 2011d. In Situ Bioremediation Program, April through June 2011 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, July.

AMEC, 2011e. In Situ Bioremediation Program, July through September 2011 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, October 31.

AMEC, 2012a. Combined 2011 Annual Groundwater Monitoring and Annual *In Situ* Bioremediation Program Report, Former 901/902 Thompson Place, Sunnvyale, California, January 31, 2012.

AMEC, 2012b. In Situ Bioremediation Program, January through March 2012 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, April 30.

AMEC, 2012c. In Situ Bioremediation Program, April through June 2012 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, July 31.

AMEC, 2012d. In Situ Bioremediation Program, July through September 2012 Progress Update, Former 901/902 Thompson Place Facility, Sunnyvale, California, October 31.

AMEC, 2013a. Combined 2012 Annual Groundwater Monitoring and Annual In Situ Bioremediation Program Report, Former 901/902 Thompson Place, Sunnyvale, California. AMEC Environment and infrastructure, Inc., January 31, 2013.

AMEC 2013b, Work Plan to Evaluate Potential Vapor Intrusion, Former 901/902 Thompson Place, Sunnyvale, California. AMEC Environment and Infrastructure, Inc., March 2013.

AMEC 2013c, Report of Results – Vapor Intrusion Evaluation, Former 901/902 Thompson Place, Sunnyvale, California. May 2013.

Geomatrix, 2005. Full-scale in situ Bioremediation Work Plan, 901/902 Thompson place, Sunnyvale, California, February.

Geomatrix, 2006. In Situ Bioremediation Program Implementation Report, Former 901/902 Thompson Place Facility, Sunnyvale, California, March 31.

Geomatrix, 2007. Letter: Request for Revision of Sampling Plan for the Former AMD Facility Located at 901/902 Thompson Place, Sunnyvale, Santa Clara County, December 20.

Haley & Aldrich, Inc., 2013a. In Situ Bioremediation Program, January through March 2013 Progress Update, Former 901/902 Thompson Place, Sunnyvale, California, April 30.

Haley & Aldrich, Inc., 2013b. In Situ Bioremediation Program, April through June 2013 Progress Update, Former 901/902 Thompson Place, Sunnyvale, California, July 30.

Haley & Aldrich, Inc., 2013c. Revised Focused Feasibility Study, Former 901/902 Thompson Place, Sunnyvale, California, September 30.

Haley & Aldrich, Inc., 2014. Vapor Intrusion Evaluation Report, Former 901/902 Thompson Place, Sunnyvale, California, February 28.

RWQCB, 2008. No Further Action for Unsaturated Zone Soil at the Former AMD Facility Located at 901-902 Thompson Place, Sunnyvale, Santa Clara County. Letter, May 14, 2008.

RWQCB, 2009a. Third Five-Year Review. Advanced Micro Devices Site, 901/902 Thompson Place, Sunnyvale, Santa Clara County, California, September 30.

TRW

AECOM, 2010. 2009 Annual Groundwater Monitoring Report, Former TRW Microwave Facility, January.

AECOM, 2011. 2010 Annual Groundwater Monitoring Report, Former TRW Microwave Facility, January.

AECOM, 2012. 2011 Annual Groundwater Monitoring Report, Former TRW Microwave Facility, January.

AECOM, 2013a. 2012 Annual Groundwater Monitoring Report, Former TRW Microwave Facility, January.

AECOM, 2013b. Work Plan for Membrane Interface Probe and Remediation Activities at the Former Source Area Excavation, Former TRW Microwave Facility, June.

AECOM, 2013c. Membrane Interface Probe (MIP) Activities Report, Former TRW Microwave Facility, 825 Stewart Drive, Sunnyvale, California, August 27.

AECOM, 2013d. Vapor Intrusion Evaluation Sampling and Analysis Work Plan, Former TRW Microwave Facility, October.

AECOM, 2014a. 2013 Annual Groundwater Monitoring Report, Former TRW Microwave Facility, January.

AECOM, 2014b. Vapor Intrusion Evaluation Report, Former TRW Microwave Facility, 825 Stewart Drive, Sunnyvale, California, February.

RWQCB, 2009b. Third Five-Year Review, TRW Microwave Site, Sep 2009, San Francisco Bay Region. September 2009.

OOU

Locus, 2011. Five-Year Status Report and Remedial Effectiveness Evaluation 2006-2010, The Companies Offsite Operable Unit, Sunnyvale, California, June.

Locus, 2012. Annual Groundwater Monitoring Report, January to December 2011, The Companies Offsite Operable Unit, Sunnyvale, California, January 30.

Locus, 2013. Annual Groundwater Monitoring Report, January to December 2012, The Companies Offsite Operable Unit, Sunnyvale, California, January 30.

Signetics (Philips) OU

Locus, 2014. NPDES Permit No. CAG912003, Self-Monitoring Report, 2013 Annual. Arques Groundwater Treatment System, 440 North Wolfe Road, Sunnyvale, California, CIWQS No. 203714, February 15.

RWQCB, 2009. Order No. R2-2009-0059, NPDES No. CAG912003. General Waste Discharge Requirements for: Discharge or Reuse of Extracted and Treated Groundwater resulting from the Cleanup of Groundwater Polluted by Volatile Organic Compounds (VOC).

Appendix B: Press Notices

PROOF OF PUBLICATION
(2015.5 C.C.P.)
County of Santa Clara
State of California

PUBLIC NOTICE

I am a citizen of the United States and a resident of the County aforesaid: I am over the age of 18 years, and not party to or interested in the above entitled matter. I am the principal clerk of the printer of the:

The Sunnyvale Sun, 1095 The Alameda, San Jose, CA 95126 a newspaper of general circulation in the City of Sunnyvale, printed in the City of San Jose, State of California, County of Santa Clara, and which newspaper has been adjudged a newspaper of general circulation by the Superior Court of the County of Santa Clara, State of California, Case Number CV742853 dated September 22, 1994 that the notice of which the annexed is a printed copy (set in type not smaller than nonpareil), has been published in each regular and entire issue of said Newspaper and not in any supplement thereof on the following dates, to wit:
Published 5/30/2014
I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Dated: May 30, 2015
At San Jose, California

Patie Greely Legal Manager

PUBLIC NOTICE
REGIONAL WATER BOARD AND EPA BEGIN FOURTH FIVE-YEAR REVIEW OF CLEANUP AT FORMER ADVANCED MICRO DEVICES, INC. (901/902)
901/902 Thompson Place; Sunnyvale, California

The California Regional Water Quality Control Board, San Francisco Bay Region (Regional Water Board) and the U.S. Environmental Protection Agency (EPA) are conducting a review of cleanup actions at the Advanced Micro Devices, Inc. (901/902) Superfund Site, located in Sunnyvale California. The review will evaluate whether the cleanup actions for the Site remain protective of human health and the environment.

This is the Fourth Five-Year Review for the Advanced Micro Devices, Inc. (901/902) Superfund Site. During this upcoming review process, the Regional Water Board and EPA will study site-specific information for the period between 2009 and 2014, and will evaluate the Site's remedial protectiveness. The Regional Water Board and EPA's project managers conductec facility inspections and will talk with company representatives, other regulatory authorities, and interestec members of the public. The methods, findings and conclusions from the review will be documented in the Five-Year Review to be issued by Fall 2014 and will be placed in the information repositories listed below.

The major chemicals of concern are TCE and its breakdown chemicals. Clean up began at the AMD 901/902 with the removal of two tanks and surrounding soil in 1983. Groundwater remediation by extraction and treatment was initiated in 1983. The original groundwater remediation system is currently not operating while alternative cleanup actions are being tested. Long-term groundwater cleanup and monitoring are required. In addition, environmental deed restrictions were recorded on these properties to prevent exposure.

The Regional Water Board and EPA invite the community to learn more about this review process and provide input about progress of the clean-up. One way to get involved is to contact Regional Water Board Project Manager Max Shahbazian at (510) 622-4824, or mshahbazian@waterboards.ca.gov or Alejandro Diaz, Community Involvement Coordinator, at (415) 972-3242 or diaz.alejandro@epa.gov. You can obtain further site information at the following Regional Water Board's website at: http://geotracker.waterboards.ca.gov/search.asp. Enter the unique Case/Global ID number for this Site, which is SL720041205. Then click on "Report", then on "Site Maps / Documents" heading.

You may also review the report and other Site documents at the Regional Water Board offices at: 1515 Clay Street, Suite 1400, Oakland, CA 94612 - phone (510) 622-2300.
Published 5/30/2014
5195882

Appendix C: Interview Forms

AMD 901/902

Five-Year Review Interview Record			
Site:	Advanced Micro Devices 901/902	**EPA ID No:**	CAD048634059

Interview Type: Visit
Location of Visit: Sunnyvale, CA
Date: 10/24/2013
Time: 10:00:00 AM

Interviewers

Name	Title	Organization
Aaron King	Environmental Engineer	USACE
Ellen Engberg	Geologist	USACE

Interviewees

Name	Organization	Title	Telephone	Email
Peter Bennett	Haley & Aldrich	Lead Hydrogeologist	(510) 879-4547	
Michael Calhoun	Haley & Aldrich	Senior Specialist, Hydrogeologist	(510) 879-4554	
Do Cao	AMD	Site Manager, Sunnyvale	(408) 749-6635	

Summary of Conversation

1) What is your overall impression of the project?

The ISB project, which incorporates elements of pump and treat and ISB, has been successful. There is good evidence of significant mass destruction.

2) Is the remedy functioning as expected? How well is the remedy performing?

The ISB treatments are generally functioning as expected. Concentration rebounding has been observed, so the ISB project may have to run longer than originally expected.

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

There are several decreasing trends in shallow groundwater in coarse grained materials. Wells in finer grained sediments have not responded.

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

There is no continuous presence (quarterly ISB performance monitoring) unless the ISB system is operating (weekly visits and monthly sampling).

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts.

Pulsed (non-continuous) operations of the ISB system started in 2011 and are still occurring. No other changes have been made.

6) What are the annual operating costs for your organization's involvement with the site?

Roughly $25,000 - $30,000.

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

The rebounding phenomenon is the only difficulty. The ISB program will likely have to run longer than originally expected.

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

No. Injection and extraction locations are rotated in order to improve lateral distribution of the carbon substrate.

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the

remedy?

The only change is the regional screening level for TCE regarding vapor intrusion.

10) Do you have any comments, suggestions, or recommendations regarding the project?

Looking forward to changing the remedy from pump and treat to ISB and MNA (submitted FFS in 2011; submitted revised FFS in Oct 2013).

Additional Site-Specific Questions

1) What is current status of ISB? Active or passive mode? Any plans to switch it to fully-active mode again? Who (what agency) makes the decision to switch ISB to active mode? What is the trigger for that change?

Pulsed operation (non-continuous) has been occurring from 2011-present. No plans to switch to fully-active mode. The state would be involved in the decision.

2) What is the status of the RWQCB's revised final site cleanup requirements?

Did not have a chance to ask Max

3) Is treated water from the ISB being discharged, and if so, where? Is there a NPDES permit or other effluent discharge requirement?

Treated water is amended and re-injected as part of the ISB process. No discharge permit.

4)ex situ GAC treatment status. Is *ex situ* treatment of extracted groundwater still used?

GAC is only used when ISB is active. Yes, for water that is to be re-injected as part of ISB. Otherwise, no.

Vessel setup: Are the tanks in series? Are the lead and lag tanks switched after GAC change-out? (Reason for this question is that one of the quarterly ISB reports states that the GAC was changed in the lag vessel in . Typically the lead vessel is changed out and then the former lag tank is switched into the lead position. Please verify during site visit how GAC change-outs are handled.)

Two 2,000 lb GAC vessels. Series. Just the lead tank is changed.

5) GAC change-out trigger: What is the trigger for changing out the GAC? Who is responsible for determining when change-outs are needed?

Exceedances from the lead vessel trigger the change. The contractor (Haley and Aldrich) is responsible.

6) Status of well ISB2AR (A-zone well). Is it an injection or extraction well? It is listed as an extraction well in the annual monitoring reports, but the figure shows it with the icon for an injection well. The location is also on the up-gradient end of the ISB treatment zone where injection is supposed to occur.

ISB2AR has been both an injection and extraction well. Extraction and injection locations are rotated to provide for better distribution of carbohydrate (initially molasses, but transitioning to sodium lactate).

7) Who performs O&M of the ISB treatment system? Who pays for the O&M?

Haley and Aldrich performs O&M. AMD pays for the O&M.

TRW

Five-Year Review Interview Record			
Site:	TRW Microwave	**EPA ID No:**	CAD009159088

Interview Type: Visit
Location of Visit: Sunnyvale, CA
Date: 10/24/2013
Time: 2:00pm

Interviewers

Name	Title	Organization
Aaron King	Environmental Engineer	USACE
Ellen Engberg	Geologist	USACE

Interviewees

Name	Organization	Title	Telephone	Email
Klaus Rohwer	Equipoise Corporation	Principal Geologist	(951) 696-7217	
Rebecca Mora	AECOM	Senior Engineer	(714) 689-7254	

Summary of Conversation

1) What is your overall impression of the project?

The source area is being controlled via the enhanced bioremediation treatments. Contamination leaving the site is the same as contamination entering the site.

2) Is the remedy functioning as expected? How well is the remedy performing?

The remedy put into place by the ROD is not even operating. However, the enhanced anaerobic bioremediation (EAB) treatments are a perfect fit for this site.

3) What does the monitoring data show? Are there any trends that show contaminant levels are decreasing?

There are decreasing trends in the source area. There are 100 ppb TCE concentrations entering the site from up-gradient, and 100 ppb TCE concentrations leaving the site down-gradient.

4) Is there a continuous O&M presence? If so, please describe staff and activities. If there is not a continuous on-site presence, describe staff and frequency of site inspections and activities.

No. Semi-annual groundwater monitoring is performed.

5) Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines in the last five years? If so, do they affect protectiveness of the remedy? Please describe changes and impacts.

The only changes in O&M requirements have been in response to EAB injections; frequency of monitoring has occasionally been increased in order to better monitor the results of EAB injections.

6) What are the annual operating costs for your organization's involvement with the site?

Roughly $45,000 total, depending on what's going on at the site in a particular year.

7) Have there been unexpected O&M difficulties or costs at the site in the last five years? If so, please give details.

There have been no difficulties related to O&M, but vandalism was a concern until the remaining old system components were removed.

8) Have there been opportunities to optimize O&M or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.

The groundwater sampling contractor switched to low flow sampling in all wells. Also, MNA was evaluated in the FFS.

9) Are you aware of any changes in Federal/State/County/Local laws and regulations that may impact the protectiveness of the remedy?

The TCE RSL and VI requirements have changed.

10) Do you have any comments, suggestions, or recommendations regarding the project? The contractors and owner are trying to get to a no further active remediation determination, but this seems rather difficult because TRW is connected to two other sites. Presence of contamination from other sites may also impact future decisions regarding vapor intrusion at the site.
Additional Site-Specific Questions
None.

Appendix D: Site Inspection Checklists

AMD 901/902 FYR Site Inspection Checklist

I. SITE INFORMATION	
Site name: Advanced Micro Devices 901/902	**Date of inspection:** 10/24/2013
Location: Sunnyvale, California	**EPA ID:** CAD048634059
Agency, office, or company leading the five-year review: State of California	**Weather/temperature:** Overcast, 60°F

Remedy Includes: (Check all that apply)

- ☐ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Monitored natural attenuation
- ☐ Groundwater containment
- ☐ Vertical barrier walls
- ☒ Other: Groundwater monitoring; in situ enhanced anaerobic bioremediation

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Do Cao, AMD — Site Manager — 10/24/2013
   Name, Organization — Title — Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☒ Report attached See Interview Record in Appendix C

2. **O&M staff** Peter Bennett, Haley & Aldrich — Lead Hydrogeologist — 10/24/2013
   Name, Organization — Title — Date
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☒ Report attached See Interview Record in Appendix C

   O&M staff Michael Calhoun, Haley & Aldrich — Senior Specialist, Hydrogeologist — 10/24/2013
   Name, Organization — Title — Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐ Report attached See Interview Record in Appendix C

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

   None.

   Agency:
   Contact: _____ _____ _____
   Name — Title — Date — Phone no.
   Problems; suggestions; ☐ Report attached _____
   _____

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)				
1.	**O&M Documents**			
	☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
	☒ As-built drawings	☒Readily available	☒ Up to date	☐ N/A
	☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A
	Remarks: Documents are not kept on site, but remediation contractors and Regional Water Quality Control Board have access to up to date copies of all required documents, not just those in this section.			
2.	☒Site-Specific Health and Safety Plan	☒ Readily available	☒ Up to date	☐ N/A
	☒ Contingency plan/emergency response plan	☒ Readily available	☒ Up to date	☐ N/A
	Remarks: Contingency plan is part of the Health and Safety Plan			
3.	**O&M and OSHA Training Records**	☒ Readily available	☒ Up to date	☐N/A
	Remarks: OSHA training records available at contractor facilities			
4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
	☐ Effluent discharge	☐ Readily available	☐Up to date	☒ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits_____	☐ Readily available	☐ Up to date	☒ N/A
	Remarks:			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks:			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks:			
7.	**Groundwater Monitoring Records**	☒ Readily available	☒ Up to date	☐N/A
	Remarks: Quarterly ISB performance monitoring; annual groundwater monitoring			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks:			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A
	Remarks:			
10.	**Daily Access/Security Logs**	☐Readily available	☐ Up to date	☒ N/A
	Remarks: No continuous on-site presence.			

IV. O&M COSTS

1. **O&M Organization**
   - ☐ State in-house
   - ☐ Contractor for State
   - ☐ PRP in-house
   - ☒ Contractor for PRP
   - ☐ Federal Facility in-house
   - ☐ Contractor for Federal Facility
   - ☐ Other

2. **O&M Cost Records**
   - ☐ Readily available ☐ Up to date
   - ☒ Funding mechanism/agreement in place
   - Original O&M cost estimate_____ ☐ Breakdown attached

   Total annual cost by year for review period if available

   From 01 Jan 2012 (Date) To 31 Dec 2012 (Date) ~$35,000 (Total cost) ☐ Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period**
   Describe costs and reasons: N/A

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A
   Remarks:

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A
   Remarks:

C. Institutional Controls (ICs)

1. **Implementation and enforcement**
   - Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
   - Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A
   - Type of monitoring (*e.g.*, self-reporting, drive by) _____
   - Frequency _____
   - Responsible party/agency _____
   - Contact _____ (Name) _____ (Title) _____ (Date) _____ (Phone no.)
   - Reporting is up-to-date ☐ Yes ☐ No ☐ N/A
   - Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A
   - Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A
   - Violations have been reported ☐ Yes ☐ No ☐ N/A
   - Other problems or suggestions: ☐ Report attached

   _____
   _____
   _____

2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A
   Remarks_____
   _____
   _____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks:

2. **Land use changes on site** ☐ N/A
Remarks: No changes. Land use remains industrial/commercial.

3. **Land use changes off site** ☒ N/A
Remarks: No changes. Land use adjacent to OU remains industrial/commercial.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks:

B. Other Site Conditions

Remarks:

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks: No wells were operating at the time of the site visit because ISB operations were not occurring.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks:

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks:

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☒ Bioremediation (in situ)
☐ Air stripping ☒ Carbon adsorbers (when ISB is occurring)
☐ Filters_____
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☐ Others_____
☐ Good condition ☐ Needs Maintenance
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☐ Quantity of groundwater treated annually_____
☐ Quantity of surface water treated annually_____
Remarks: Molasses has been the carbohydrate of choice, but the contractor is transitioning to sodium lactate. Carbon vessels were not on-site during the site visit because ISB operations were not occurring at the time.

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks:

3. **Tanks, Vaults, Storage Vessels**
☒ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks:

4.	**Discharge Structure and Appurtenances** ☒ N/A ☐ Good condition ☐ Needs Maintenance Remarks:
5.	**Treatment Building(s)** ☒ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks:
6.	**Monitoring Wells** (pump and treatment remedy) ☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒Good condition ☐ All required wells located ☒ Needs Maintenance ☐ N/A Remarks: Some well covers (PMW-1, 28-MW, and 28-D) were missing bolts. These should be replaced so the wells can be properly secured.
D. Monitoring Data	
1.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
2.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☐All required wells located ☒Needs Maintenance ☐N/A Remarks: Some well covers (PMW-1, 28-MW, and 28-D) were missing bolts. These should be replaced so the wells can be properly secured.
X. OTHER REMEDIES	
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The remedy as described in the ROD is no longer operating. Portions of the pump and treat remedy are used in conjunction with the ISB injections. A revised FFS was submitted in Oct 2013 and is awaiting approval from the Regional Water Board and EPA. The revised FFS recommends the remedy change to ISB and MNA as a final remedy.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. O&M procedures appear to be sufficient for the current site operations.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. Concentrations have rebounded in some wells, likely due to contaminant diffusion from finer grained materials. As a result, the ISB program may need to run for longer than originally expected.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Some wells are operated alternately as injection and extraction wells to improve the lateral distribution of the injected carbon substrate.

TRW Site Inspection Checklist

I. SITE INFORMATION	
Site name: TRW Microwave	**Date of inspection:** 10/24/2013
Location: Sunnyvale, CA	**EPA ID:** CAD009159088
Agency, office, or company leading the five-year review: State of California	**Weather/temperature:** Partly cloudy, 60°F

Remedy Includes: (Check all that apply)

☐ Landfill cover/containment ☐ Monitored natural attenuation
☐ Access controls ☐ Groundwater containment
☐ Institutional controls ☐ Vertical barrier walls
☐ Groundwater pump and treatment (suspended in 2001)
☐ Surface water collection and treatment
☒ Other: Groundwater monitoring, enhanced anaerobic bioremediation, soil vapor extraction (removed in 1998)

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
Problems, suggestions; ☐ Report attached _____
_____

2. **O&M staff** Klaus Rohwer, Principal Geologist, Equipoise Corporation 10/24/2013
Name Date
Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
Problems, suggestions; ☐ Report attached See Interview Record in Appendix C.

O&M staff Rebecca Mora, Senior Engineer, AECOM 10/24/2013
Name Date
Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
Problems, suggestions; ☐ Report attached See Interview Record in Appendix C.

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency:
Contact: _____ _____ _____
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached _____
_____

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A
☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A

Remarks: Documents are not kept on site, but remediation contractors and Regional Water Quality Control Board have access to up to date copies of all required documents, not just those in this section. These are updated as needed.

2.	☒**Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A ☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A Remarks: Contingency plan is part of the Health and Safety Plan. Updated as needed.	
3.	**O&M and OSHA Training Records** ☒ Readily available ☒ Up to date ☐N/A Remarks: OSHA training records available at contractor facilities	
4.	**Permits and Service Agreements** ☐ Air discharge permit ☐ Readily available ☐ Up to date ☒ N/A ☐ Effluent discharge ☐ Readily available ☐Up to date ☒ N/A ☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☒ N/A ☐ Other permits_____ ☐ Readily available ☐ Up to date ☒ N/A Remarks:	
5.	**Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A Remarks:	
6.	**Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A Remarks:	
7.	**Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐N/A Remarks: Groundwater monitoring is performed semiannually.	
8.	**Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A Remarks:	
9.	**Discharge Compliance Records** ☐ Air ☐ Readily available ☐ Up to date ☒ N/A ☐ Water (effluent) ☐ Readily available ☐ Up to date ☒ N/A Remarks:	
10.	**Daily Access/Security Logs** ☐Readily available ☐ Up to date ☒ N/A Remarks:	
	IV. O&M COSTS	
1.	**O&M Organization** ☐ State in-house ☐ Contractor for State ☐ PRP in-house ☒ Contractor for PRP ☐Federal Facility in-house ☐ Contractor for Federal Facility ☐ Other	
2.	**O&M Cost Records** ☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place Original O&M cost estimate_____ ☐ Breakdown attached Total annual cost by year for review period if available From 01 Jan 2012 To 31 Dec 2013 ~$45,000 ☐Breakdown attached Date Date Total cost	
3.	**Unanticipated or Unusually High O&M Costs During Review Period** Describe costs and reasons: N/A	
	V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A	
A. Fencing		
1.	**Fencing** ☐ Location shown on site map ☐Gates secured ☐ N/A Remarks: The fencing where the extraction system used to be is still in place and in good condition, but people have easy access to the site (the exterior of the building). The building is locked at all times; only those with proper keys are able to access the building.	
B. Other Access Restrictions		

1.	**Signs and other security measures** ☐ Location shown on site map ☒ N/A Remarks:
C. Institutional Controls (ICs)	
1.	**Implementation and enforcement** Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A Type of monitoring (*e.g.*, self-reporting, drive by) _____ Frequency _____ Responsible party/agency _____ Contact _____ _____ _____ _____ Name Title Date Phone no. Reporting is up-to-date ☐ Yes ☐ No ☐ N/A Reports are verified by the lead agency ☐ Yes ☐ No ☐ N/A Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☐ N/A Violations have been reported ☐ Yes ☐ No ☐ N/A Other problems or suggestions: ☐ Report attached _____ _____ _____
2.	**Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A Remarks_____ _____
D. General	
1.	**Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident Remarks: Equipment that had been vandalized has since been removed.
2.	**Land use changes on site** ☐ N/A Remarks: No changes. Land use remains industrial/commercial. Onsite building remains unoccupied.
3.	**Land use changes off site** ☐ N/A Remarks: No changes. Land use remains industrial/commercial.
VI. GENERAL SITE CONDITIONS	
A. Roads ☒ Applicable ☐ N/A	
1.	**Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A Remarks:
B. Other Site Conditions	
	Remarks: Homeless/vagrants have been occasionally spotted in the outdoor portion of the site.
VII. LANDFILL COVERS ☐ Applicable ☒ N/A	
VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A	
IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A	
A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A	
B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A	
C. Treatment System ☒ Applicable ☐ N/A	

1.	**Treatment Train** (Check components that apply) ☐ Metals removal ☐ Oil/water separation ☒ Bioremediation (EAB) ☐ Air stripping ☐ Carbon adsorbers ☐ Filters_____ ☐ Additive (*e.g.*, chelation agent, flocculent)_____ ☐ Others_____ ☐ Good condition ☐ Needs Maintenance ☐ Sampling ports properly marked and functional ☐ Sampling/maintenance log displayed and up to date ☐ Equipment properly identified ☐ Quantity of groundwater treated annually_____ ☐ Quantity of surface water treated annually_____ Remarks: In situ enhanced anaerobic bioremediation is the only treatment occurring at the site. EAB injections have included: Hydrogen Release Compound (HRC), cheese whey, EVO, ABC+, and EHC-L.
2.	**Electrical Enclosures and Panels** (properly rated and functional) ☒N/A ☐ Good condition ☐ Needs Maintenance Remarks:
3.	**Tanks, Vaults, Storage Vessels** ☒N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance Remarks:
4.	**Discharge Structure and Appurtenances** ☒ N/A ☐ Good condition ☐ Needs Maintenance Remarks:
5.	**Treatment Building(s)** ☒ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks:
6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks: Wells generally in good condition. Some settlement observed near Well T-10C (see site photographs).
D. Monitoring Data	
3.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
4.	Monitoring data suggests: ☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
D. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition ☐All required wells located ☐Needs Maintenance ☐N/A Remarks: Wells generally in good condition. Some settlement observed near Well T-10C (see site photographs).
X. OTHER REMEDIES	
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**

	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The remedy as described in the ROD is no longer operating and has been dismantled and removed. Enhanced anaerobic bioremediation (EAB) operations have been occurring at the site. EAB injections include HRC, cheese whey, emulsified vegetable oil (EVO), ABC+, and EHC-L.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. O&M procedures appear to be sufficient for the current site operations.
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. There have been no indicators of problems with EAB treatments thus far. The migration of off-site contamination on site presents problems for the site regarding both vapor intrusion and the desire for a no further action (NFA) determination.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. MNA was investigated in the FFS and low flow sampling is now used for all groundwater monitoring.

Appendix E: Photographs from Site Inspection Visit

AMD Site Photographs

AMD Photo 1. Monitoring wells DW-1 (near) and DW-2 (far) near the former 901 building source zone.

AMD Photo 2. A-zone wells ISB1AR (near) and ISB2AR (mid) near the former 901 building source zone.

AMD Photo 3. Monitoring well PMW-2 near the former 901 building source zone.

AMD Photo 4. View looking inside the treatment system enclosure. GAC vessels are located here when ISB is operating.

AMD Photo 5. Close-up of well PMW-1 north of the former 901 building.

AMD Photo 6. Another view of well PMW-1.

AMD Photo 7. Monitoring wells 28-D and 28-S located north of the former 901 building.

AMD Photo 8. Treatment System Enclosure fencing north of the former 901 building.

TRW Site

TRW Photo 1. TRW Microwave Building (unoccupied)

TRW Photo 2. Cheese whey injection point.


TRW Photo 3. ABC+ injection points

TRW Photo 4. Location of former extraction and treatment system (components have been removed.

TRW Photo 5. Former trenching for extraction system.

TRW Photo 6. Cheese whey and EHC-L injection point.


TRW Photo 7. Closer view of location of former extraction system.

TRW Photo 8. Well T-10C.

TRW Photo 9. Well T-17B.

TRW Photo 10. Source zone (inside building).

TRW Photo 11. Typical investigation points up-gradient of source zone.

Appendix F: Supporting Documentation for Data Review

Supporting Documentation for Data Review

Additional supporting information from the data review that is not included in the main body of the FYR is included in this appendix.

AMD

Table F-1. AMD 901.902 Groundwater Monitoring Wells

Well ID	Screened Aquifer Zone	Sampling for COCs (annually)	Sampling for COCs (quarterly)	Location relative to ISB area
15-S	A	Y		Up-gradient
16-S	A	Y		ISB area
22-S	A	Y		ISB area
23-S	A	Y	Y	ISB area
27-S	A	Y		Up-gradient
28-S	A	Y		ISB area
29-S	A	Y		Up-gradient
36-S	A	Y		Down-gradient
37-S	A	Y		Down-gradient
28-MW	A		Y	ISB area
DW-2	A			ISB area
X2A	A			ISB area
16-D	B1	Y		ISB area
23-D	B1	Y	Y	ISB area
27-D	B1	Y		Up-gradient
28-D	B1	Y		ISB area
29-D	B1	Y		Up-gradient
36-D	B1	Y		Down-gradient
52-D	B1	Y		Up-gradient
53-D	B1	Y		Up-gradient
DW-1	B1		Y	ISB area
PMW-1-1	B1		Water levels only	ISB area
PMW-1-2	B1		Water levels only	ISB area
PMW-1-3	B1		Water levels only	ISB area
PMW-2-1	B1		Y	ISB area
PMW-2-2	B1		Water levels only	ISB area
X2B1	B1		Y	ISB area
X1B	B1		Y	ISB area
DW-7	B1		Y	ISB area
22-DD	B2	Y		ISB area
27-DD	B2	Y		Up-gradient
36-DD	B2	Y		Down-gradient
PMW-2-3	B2		Y	ISB area
35-DDD	B3	Y		ISB area

TRW

Table F-1. TRW Groundwater Monitoring Well Sampling Scope and Frequency

Well ID	Screened Aquifer Zone	Sampling for COCs (annual)	Sampling for COCs (semi-annual)	Location relative to former source area
Eductor	A	Y	Y	In source area
T-2A	A	Y		In source area
T-3A	A	Y		Down-gradient
T-6A	A			Down-gradient
T-7A	A	Y		Up-gradient
T-8A	A	Y	Y	Down-gradient
T-9A	A	Y		Down-gradient
T-13A	A	Y	Y	Down-gradient
T-14A	A	Y	Y	Down-gradient
T-15A	A	Y		Down-gradient
T-16A	A	Y		Down-gradient
T-17A	A	Y		Down-gradient
T-18A	A			Down-gradient
T-19A	A	Y	Y	Down-gradient
T-20A	A			Down-gradient
T-21A	A			Down-gradient
T-22A	A			Down-gradient
T-23A	A	Y	Y	Down-gradient
T-24A	A	Y		Down-gradient
T-25A	A	Y	Y	Down-gradient
36S	A	Y		Up-gradient
36D	A	Y		Up-gradient
37S	A	Y		Up-gradient
38S	A	Y		Down-gradient
T-2B	B1	Y	Y	In source area
T-4B	B1	Y		Down-gradient
T-5B	B1	Y		Up-gradient
T-7B	B1	Y		Up-gradient
T-8B	B1	Y		Down-gradient
T-9B	B1	Y		Down-gradient
T-10B	B1	Y		Down-gradient
T-17B	B1	Y		Down-gradient
T-18B	B1	Y		Up-gradient
T-19B	B1	Y		Crossgradient
T-2C	B2	Y		In source area
T-9C	B2	Y		Down-gradient
T-10C	B2	Y		Down-gradient
T-11C	B2	Y		Down-gradient
T-12C	B2	Y		Down-gradient
36DD	B2	Y		Up-gradient